THE

Practical Teacher

A MONTHLY EDUCATIONAL JOURNAL

Edited by JOSEPH HUGHES.

'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

AIR: ITS HYGIENIC PROPERTIES.

(*Continued.*)

Ozone is oxygen in a condensed state; it is always present in the fresh air, but is absent in the close air of rooms, and not always found out of doors in large towns, and but seldom in great cities. It may be found on one side of a town on one day, and absent in the same place on the next, simply because the wind has changed to the opposite quarter. We do not know how it is formed in nature. It may be evolved by electric action, or oxygen, set free by various agencies may take the form of ozone when first eliminated. It has a peculiar smell. It is able to set iodine free from potassium iodide, by which its presence may be recognised with certain limitations. The smell which is observed when an electric machine is worked is that of ozone. It is half as heavy again as oxygen; that is, 2 vols. of ozone form 3 vols. of oxygen. It is an important agent in all sanitary operations; probably produced by motion, and set free by growing plants, and by other chemical actions, it assists to diminish the incidence of disease-producing agencies. It seizes upon the so-called albumenoid ammonia compounds, oxidizes them, and renders them comparatively harmless. It is found near to the surface of the sea, probably in some way connected with the physical changes which are always going on at the surface of the water, when that water is in constant movement. Its presence in the air on one side of a great city and its absence in the other, arises from its being used up in oxidizing the organic matters which have been discharged into the air by the decomposition of dead matter in the city. Thus ozone is never found where such decomposition is going on, when that is in excess of the quantity of ozone produced. Its production is associated with many of the processes which are in vogue for the purification of the atmosphere. It may be simply oxygen in an electrified form, intimately associated with the molecular state of the gas, but chemists are not thoroughly agreed as to its nature. Those who wish for more information upon this agent and its associations should study Dr. Cornelius Fox's important work on Ozone and Antozone, which gives a complete account of the 'when, where, why, and how is Ozone observed in the atmosphere.'

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NH_3 is collected by drawing the air by means of an aspirator through wash-bottles containing a measured quantity of water which is perfectly free from NH_3 and by then determining the free and albumenoid NH_3 by Wanklyn's method. This process should be studied by all who are engaged in sanitary work. It is set out in full in 'Water Analysis,' by J. A. Wanklyn, to which I must refer the reader, as space prevents me giving all the details.

Ozone is indicated by test papers which have been dipped in solution of KI and starch. The paper should be exposed for a definite time, if possible, with exclusion of light. The quantity of ozone is said to be made out by observing the depth of blue colour produced and comparing it with a scale which has been previously assessed at its value. The conclusion may be erroneous, as nitrous acid (N_2O_3) will affect the test paper when present to the extent of $\frac{1}{100000}$ of the volume of the air, and a minute portion of the

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iodine set free never acts upon the starch, as it is immediately volatilized or oxidized. These agencies can, however, be averaged and allowed for.

Microscopical Examination of Air.—There are a great number of materials found suspended in the air, organic as well as inorganic. The observations which have been recently made out connected with the magnificent sunsets of 1883 will be a case in point, for it seems to be established beyond refutation that the minute dust from volcanic action reaching the upper regions of the air, continue to circulate round the earth for long periods before the whole is again deposited upon its surface. These particles allow of refraction, and so produce the colours which have been so manifest at eventide. The matters suspended in the air may be collected by arranging a small funnel with a microscopical slide below its point, which has been moistened with glycerine. The end of the funnel must be with the slip of glass enclosed in an air-tight chamber, such as is provided by Pouchet's aeroscope; from this a small glass tube passes out and is connected with an aspirator; as the water runs away, the air impinges on the slide, any solid particles which it may contain are arrested by the glycerine, or the air may be drawn through pure distilled water and the resulting deposit examined after it has settled. The collected inorganic particles are found to be particles of *silica*, *calcium salts*, and *iron oxides*. If the water is slowly evaporated, *chlorides* are found, especially if the specimen has been collected near the sea. A large number of living cells and the debris of dead creatures are sometimes arrested. Ehrenberg collected more than 200 forms of *rhizopods*, *tardigrades*, and *anguillula*, *micrococci*, *bacteria*, *spores of fungi*, varying with the season of the year; *pollen* from flowers, *starch grains*, *dried cells* of all kinds, such as those of *pus* and *mucus*, *epidermic* scales both animal and vegetable. It has been shown how very minute particles are made visible by a ray of light passing through a dark room, as any one may see for himself. The suspended matters which are found in enclosed spaces are indicative of the actions which are taking place in those spaces. The dust from the ward of a hospital contains just those particles which we might expect to find there—germs which will propagate disease if carried to a favourable site. It is probable that cattle diseases, such as pleuro-pneumonia and foot-and-mouth disease, are spread in this way, whilst small pox, scarlatina, and measles, may owe their diffusion to a similar source; and erysipelas may be spread from case to case by currents of air, carrying with them the spores which are able to create the disease.

Some of these spores may be dried and retained as dust for long periods; when moistened with water they revive and are able to propagate their species or set up the disease anew. The air of mines, workshops, and factories are seen to contain particles sufficiently numerous to set up diseases in the lungs, etc., of the workpeople employed, whilst in some occupations, such as woolsorters, disease so often arises that it becomes recognised by the name of the occupation of the persons attacked. Bacilli of various kinds are cultivated in the raw material which is being worked into a manufactured article, and the hands employed may suffer seriously from the effects of the cacozyme.

Sewer air may propagate disease by carrying the germs and discharging them by ventilators into the open street, to the possible injury of the passengers. When sewers smell, there is a fault somewhere, which should be rectified by a removal of its cause, not, as is too often the case, simply by closing the opening from which the smell comes. The air of vaults may be shown to contain injurious particles, and organic matter has been arrested in air from marshes which is supposed to be the cause of intermittent fever. It is certain that microscopical examination of air will, in the future, be a necessary part of the work of a disease preventer.

THE REMOVAL OF WASTE AND IMPURITIES.

The waste which arises from the mere act of living, the impurities which necessarily follow from that act, and which must be incessantly removed, are some of the most difficult problems of sanitary work in great towns. The impurities consist of defilements of the air which have to be reduced to the lowest amount by natural ventilation if possible, and if natural ventilation is not equal to the work, then by artificial means. They also consist of the natural refuse from sinks, baths, and closets, and are intimately associated with the formation of drains and sewers, as well as of traps and means for ventilating the same. The removal of such impurity invites a question as to the transit of sewage by the dry method or by water carriage. It entails a consideration also of sewer gas and septic organisms generally, as well as the use of antiseptics, deodorisers, and disinfectants. We will consider each of these under its separate heading.

Ventilation.—The means whereby air is set in motion may be considered under two heads. 1. Natural. 2. Artificial.

Natural Ventilation.—This is promoted by changes in temperature and moisture; by the winds; and by the law which causes the diffusion of gases through space. The changes in temperature and moisture are such as arise from the unequal weight of the air when heated by the sun's rays or chilled by cold blasts from distant regions. Tables are given in scientific works by which calculations are made as to velocities produced by difference of temperature, and rules are laid down for making the calculations. In ordinary cases the difference in pressure cannot be obtained by direct observation, but must be gathered by finding out the difference of temperature of the outer and inner air of the room under consideration. A formula is given by Prof. de Chaumont, which is as follows: 'The height from the aperture at which air enters to that from which it escapes multiplied by the difference of temperature between the outside and inside and divided by 491.' This will give the actual movement produced by unequal weight of air. The 491 indicates the fraction which is called the co-efficient of the expansion of gases. If Fahrenheit is the thermometer employed, it should be remembered that the volume of a gas expands $\frac{1}{491}$ times for every degree of risen temperature, or $\frac{1}{273}$ if the Centigrade is used.

Another rule may also be remembered with advantage, viz., that air rushes into a vacuum with a velocity which a heavy body would acquire in falling from a height of five miles, viz., 1,304 feet per second. The velocity in feet per second of falling bodies is equal to nearly eight times the square root of the height through which they have fallen, and fluids pass through an orifice in a partition with a velocity which is equal to that which a body attains in falling through a height

equal to the difference in depth of the air on the two sides of the partition. This is called the Rule of Montgolfier. The causes of movement are constantly acting with every change of temperature, and it is added to by the alteration in moisture which such changes bring about. There are losses of power produced by friction and angles, but these are not great except in cases when the openings are too minute to be of much service. The most powerful ventilating agent is the wind; its agency must be considered in all plans for ventilating a given place. The pressure of the wind equals three-quarters of an ounce on each square foot when the air moves at the rate of three miles per hour; 2 ozs. at five miles; 4 ozs. at seven miles; 8 ozs. at 10 miles; and 1 lb. when the air travels at the rate of fourteen miles per hour. This power of the wind is but too often forgotten in artificial systems of ventilation. It can be always more or less trusted to, if there is room for open windows and simple ventilating apertures. These openings allow the changes of temperature and moisture (which must arise when a number of people occupy a room) to come into play. The great difficulty is to arrange the openings so that a draught may not impinge upon some of the occupants, the result of which is but too generally an outcry on their part for the opening to be closed. Windows should always be placed at opposite sides of the room. They should reach to the ceiling, and open both top and bottom. The top sash may be made to open inwards, so that the draught may be towards the ceiling in the first instance; a wire gauze may cover the space which is left at the lower part when the sash is raised, provided care be taken that the gauze be kept clean. Various kinds of ventilators are provided, such as glass louvres, movable sheets of glass with perforated mouldings. Tobin's tubes, by which air is brought from pure sources and delivered in the room at suitable places, pierced conical bricks, etc., etc. It is necessary to consider—1st. The inlets for fresh air. 2nd. The exits for used-up air; and 3rd. the number of people who are likely to occupy the room or building.

(To be continued.)

—o—

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

THE work for Standard V., as set forth in the code, is as follows:—(*a*) Animal or plant life; (*b*) the chemical and physical principles involved in one of the chief industries of England, among which agriculture may be reckoned; (*c*) the physical and mechanical principles involved in the construction of the commoner instruments, and of the simpler forms of industrial machinery.

This syllabus is extremely vague—probably intentionally so—in order to allow the teacher a wide freedom of choice. As a matter of fact, however, we require no further explanation of the general intention of the Department beyond that given in the instructions—'to prepare a progressive course of lessons adapted to cultivate habits of exact observation, statement, and reasoning.'

It will, of course, be necessary for the teacher to arrange a syllabus of about sixty lessons and submit it to H.M. Inspector. A reading book on 'Elementary Science' is required for Standard V.; and the scheme of lessons will necessarily be based upon the contents of that book. I will assume that No. 3 of 'Hughes' Science Readers' is used. From page 1 to page 60 treats of the following subjects:—The three states of matter; the physical properties peculiar to each state; simple machines; heat. Here is ample material for a year's work. A course of sixty lessons may easily be arranged from this bare outline. As a fact, this part of the reader exactly embraces the work for the first stage 'Mechanics' as given in the 'Fourth Schedule' of the code; and if I were taking 'Mechanics' as a specific subject, I should certainly use this book as the 'General Reader' for Standard V. A complete syllabus of lessons on this division of the book appears in volume I. page 223 of this magazine; hence, I need not repeat here what I then gave with considerable detail.

From page 86 to page 174 of the class-book we have material for another and distinct course of lessons. The subject is 'Elementary Chemistry.' Hence the teacher who uses this book has a choice of two subjects to serve as the basis of his lessons on Elementary Science for Standard V. He may confine his attention to the first part of the book and take 'Natural Philosophy,' or he may devote the time to 'Elementary Chemistry.' I will assume the latter course is adopted. The following is therefore a syllabus of lessons in 'Elementary Science' as a class-subject for Standard V., based upon the contents of the latter part of 'Hughes' Science Reader,' No. 3.

LESSONS I. to IV.

Elements and compounds; composition of chalk and red oxide of mercury.

LESSONS V. and VI.

Difference between a chemical compound and a mechanical mixture. Composition of water and of air.

LESSONS VII. to X.

Analysis and synthesis. Analysis of red oxide of mercury; of chalk; and of water. The combination of oxygen and iron; of carbon dioxide and lime; and of the fumes of hydrochloric acid and ammonia.

LESSONS X. and XI.

The chemistry of air. Experiment with the bell-jar and phosphorus.

LESSONS XII. and XIII.

Oxygen: its preparation and properties.

LESSONS XIV. and XV.

Hydrogen: its preparation and properties.

LESSONS XVI. and XVII.

The chemistry of water. Analysis by (*a*) heat; (*b*) electricity; (*c*) sodium.

LESSONS XIX. to XXII.

Chief compounds of oxygen. (*a*) Oxide of iron; (*b*) oxide of mercury; (*c*) carbon dioxide; (*d*) nitrous oxide, etc.

LESSON XXIII.

Carbon: its various forms and chief properties.

LESSONS XXIV. and XXV.

Chief compounds of carbon. (*a*) Carbon dioxide; (*b*) hydro-carbons.

LESSON XXVI.

Nitrogen: its preparation and properties.

LESSONS XXVII. to XXX.

Ammonia: its source, properties, and compounds.

LESSONS XXXI. and XXXII.

Chlorine: its preparation and properties.

LESSONS XXXIII. to XXXVI.

Compounds of chlorine. (*a*) Chloride of lime; (*b*) chloride of ammonia; (*c*) chloride of sodium.

LESSONS XXXVII. to XL.

Phosphorus: its mode of preparation, uses, and compounds.

LESSONS XLI. to XLIV.

Sulphur: its mode of preparation and chief compounds.

LESSONS XLV. to L.

Economic chemistry, *e.g.*, chemistry of food. Fats, sugar, starch, cellulose, milk, cheese, etc.

LESSONS LI. to LX.

Agricultural chemistry. Composition of wheat and other kinds of corn; of roots, etc.; composition of soils.

It will at once be seen that the above syllabus, besides being adapted for the class-subject 'Elementary Science' for Standard V., is also arranged to suit the requirements of the first stage of the specific subject—'Chemistry.' In the Fourth Schedule of the code we find the following outline given as indicating the work of the first stage of this specific subject:—'Elementary and compound matter. Illustrations of combination and decomposition in such bodies as hydrochloric acid, water, oxide of mercury, and rust of iron.' The 'Science Reader' (Hughes') so exactly embraces this official syllabus that, as I intend taking 'Chemistry' as a specific subject next year, I shall certainly use this book as the 'general' reader for Standard V.

Perhaps it may be well I should here mention that my arrangement of 'Elementary Science' as a class-subject in Standards I. to IV. inclusive is intended to lead up to the specific subjects in Standards V. to VII.; and that 'Chemistry' and 'Mechanics' are the two specifics I have chosen. *This* year, however, being with me a ten-months' year, and my school quite a new school, I am not taking any specific subjects at all. And I should strongly advise all teachers opening new schools to follow my plan in this respect; for if, while the school is only partly full, and there are comparatively few boys in the upper standards, these subjects are begun, the work is thrown into considerable confusion in future years. I would, of course, from the very day of the opening of the school, start an interesting and attractive series of object lessons, not for examination purposes, but merely to make the school a popular one in the neighbourhood.

There is one point in connection with this subject of chemistry that I ought to explain. The nomenclature of the science, as well as the manner of stating the chemical formulæ, are at present in an unsettled state. This is, of course, inevitable in the case of such a progressive science as chemistry, where fresh discoveries are continually being made, involving the modification of old statements and the adoption of an altered formula. The symbols, however, remain the same. For instance, the symbols H, O, N and Ca stand respectively for hydrogen, oxygen, nitrogen, and calcium. Shall I, for 'water' and 'ammonia,' write H_2O and H_3N, placing the electro-positive element first (as being the one which appears at the negative pole during electrical analysis), or shall I use as formulæ for these binary compounds OH_2 and NH_3, as I find Dr. Frankland does in his 'Lecture Notes for Chemical Students'? And with respect to the nomenclature. Shall I, in the case of the compounds CO, CO_2, and H_2CO_3, use the terms carbonic oxide, carbonic anhydride, and carbonic acid? or shall I call the first oxide of carbon, and the second carbon dioxide and carbonic acid indifferently? Shall I call chalk calcic carbonate, or carbonate of lime? For the compound expressed by the formula K_2SO_4 which term shall I use? Sulphate of potash, or sulphate of potassium, or dipotassic sulphate, or potassium sulphate?

It is quite evident that before I begin to teach even little boys the most elementary chemistry, I must settle what nomenclature to use, and what system of formulation to adopt. My difficulty is just this. I must assume that *some* at least of my boys will pursue the subject further when they leave school. Well, what will they then think of me and my teaching if they find to their cost that most of what I have told them they have to *unlearn* before going any further? They will perhaps conclude that I had far better have taught them nothing. And yet I cannot possibly be continually referring to the same substance under three or four different names, nor every time I use a formula show that there are very good reasons why it should be written in two or three other ways.

I have decided in these notes to use the ordinary names and the most commonly received formulæ, except in cases where such are positively erroneous. For instance, I shall use the term 'oxide of iron' in preference to 'ferric oxide,' and adopt the formula H_2O (water) rather than OH_2. I shall, however, call CO_2 carbon dioxide, and not carbonic acid, for the simple reason that it is not an acid at all with the H_2O abstracted, there being in CO_2 no hydrogen for a metal to displace; it is, in fact, an anhydride.

I feel there is no injustice done to the boys by the adoption of these terms, because my lessons will deal only with the most common every-day substances, to which common every-day names will always be given. If I were teaching a class of adults, the case would be quite different. *Then* most assuredly I should follow Dr. Frankland's system, and as certainly, Dr. Aveling's method of teaching.

(To be continued.)

"The Practical Teacher" Music Competition—First Prize (School Songs).

THE CHILD'S FIRST GRIEF.

Words by MRS. HEMANS.

Music by WM. REES,
Meliden National School, Rhyl.

Andante.
TREBLE.
ALTO.
TENOR.
BASS.
1. "Oh, call my bro - ther back to me, I can - not play a - lone! The
2. "He would not hear thy voice, fair child, He may not come to thee: The
3. "And has he left his birds and flow'rs? And must I call in vain? And
KEY D. Andante. p
sum - mer comes with flow r and bee—Where is my bro - ther gone? Where is my bro - ther gone?
face that once like sum - mer smiled, On earth no more thou'lt see, On earth no more thou'lt see.
through the long, long sum - mer hours, Will he not come a - gain? Will he not come a - gain?
rall.
tempo.
mf
The flowers run wild, the flowers we sowed A - round our gar - den tree; Our
A rose - s brief bright life of joy, Such un - to him was given: So
And by the brook, and in the glade, Are all our wand - 'rings o'er?— Oh,
f
vine is droop-ing with its load—Oh, call him back to me! Oh, call him back to me!"
thou must play a - lone, my boy—Thy bro - ther is in heaven! Thy bro-ther is in heaven!"
while my bro - ther with me played, Would I had loved him more! Would I had loved him more!"
p
pp rall.

"Practical Teacher" Money Prize Competition—First Prize (Action Songs

'TIS SPRING-TIME.

Words and Music by R. P. GRAHAM, A.C.P.
Board Schools, Harrington, Cumberland.

Brightly.
1st TREBLE.
2nd TREBLE.
mf
1. 'Tis spring-time, bright spring-time! all na-ture is gay, For winds cold and
2. The farm-er with keen plough is till-ing the ground, (3) Then seeds with his
3. The buds on the hedge-rows all o-pen out so, (7) And gay-co-loured
4. The song of the sky-lark so joy-ous doth rise, As cheer-ful and
BASS.
KEY D. Brightly. mf
1st TREBLE.
2nd TREBLE.
BASS.
pierc-ing have all passed a-way; (1) And now the bright sun-shine gives warmth to the
hands he will scat-ter a-round: (4) The lit-tle birds build their warm nests in the
blos-soms be-gin now to grow; (5) The dai-ses, and cow-slips, and prim-ros-es
hap-py now up-ward he flies: (6) The lamb-kins are skip-ping and run-ning with
f
air, And chang-es de-light-ful are seen ev-'ry-where.
trees, (5) And twit-ter and chirp as they fly in the breeze. (6)
sweet, We make in-to nose-gays, so pret-ty and neat. (8)
glee— A pleas-ing ex-am-ple to you and to me. (9)
Hip, hur-rah! hip, hur-
f
-rah! (2) Let us all sing to-ge-ther, bright spring is here!

(1) Rub hands briskly together, then gradually extend them right and left respectively. (2) Wave right hand twice. (3) Extend arms to the front, fists closed. (4) Imitate sowing of seed. (5) Point to the right or left. (6) Hands raised to level of head, fingers in rapid motion. (7) Hands partly extended to front, palms facing upwards, tips of fingers and thumb together at first, then expanded. (8) Imitate the act of smelling flowers. (9) Point with extended finger.

Article 106 (b).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE MOON AND STARS.

LAST week we had a long talk about the sun. Do you remember anything you told me about it? It gives us light and heat, it makes the plants and flowers grow. Yes, that is right. When do we see the sun? In the daytime. Do you ever see it at night? No. Well, I went out last night, and saw something very bright in the sky. What was that? It was the moon. How many of you saw the moon last night? Not many of you; how was that? Yes, you were in bed. Do you know if the moon shines every night? No, sometimes there is no moon to be seen. So, you see, sometimes the moon shines very brightly, and at other times you cannot see it. Now, perhaps, some of you who have seen the moon can tell me something about its shape. It is round like the sun. Is it always round? No, sometimes it has a little piece off one side. Sometimes there is only half a moon. Sometimes only a quarter, and sometimes only a very little strip. So, you see, the moon does not always seem the same shape to us. When the moon is only a little strip we say it is the new moon. If you watch the new moon, you will see that after a few nights it is much larger. The moon goes on getting larger until it gets quite round. Can you tell me what we say of it then? We say it is the full moon. If you had noticed the first day of the new moon, and kept count of the days, you would find that fourteen days had passed while the moon was becoming full. Do you know what happens when the moon is full? It begins to get smaller. Yes, first it gets to half a moon, and then smaller and smaller. How long do you think the moon is in getting quite small again? Fourteen days. Yes, just the same time as it took to become quite round. Who can tell me how many weeks there are in fourteen days? Two weeks. Then, you see, the moon is two weeks getting large, and two weeks getting small. How many weeks is that? Four weeks. What do four weeks make? A month. Yes, we say there is a new moon every month. When the moon is getting smaller we say it is 'on the wane.' What does the moon give us? Light. Yes, we like to walk out when the moon is shining brightly. The light makes everything look so pretty. Can you look at the moon? Yes, it does not hurt our eyes like the sun. Why not? Because it is not so strong. The light that comes from the sun is of a golden colour, but the light of the moon is white like silver, so that we always talk about the silvery moon and the golden sun.

Very often at night the moon does not shine, and then it would be very dark indeed if something else did not try to give us light. What do you think I mean? The stars. What can you tell me about them? There are a great many stars all over the sky. What can you say about their size? They are very small, some much smaller than others. What else can you tell me? They are very bright and seem to be moving or dancing about. What do we call this kind of moving? You do not know. There is a pretty little song you sing about the stars that tells you what they do. Now sing me part of that song? 'Twinkle, twinkle, little star.' Well, then, what can you say about the movement of the stars. They twinkle. Do you like to see the stars? Yes, they look very bright and pretty in the sky. Of what colour are they? They are silvery like the moon. Do you see the stars only when there is no moon shining? Oh no, sometimes we see both the moon and stars. Do you think you could reach the stars? No, they are a long way off. If you were to build a house on the top of another very high indeed, you would still not be able to touch the sky. It is very far away.

Section II.—Scenes of Common Life.

LESSON—MODES OF CONVEYANCE.

I. *The different modes of conveyance to be named.*—Now, children, let us suppose we have a half-holiday. Where would you like to go? To Richmond—Regent's Park—Zoological Gardens. Yes, we could go to any of these places and have a very happy time, but we will imagine we are going to the Zoological Gardens this afternoon. I wonder who can tell me how we can get there. Where are we now? At school. Yes, but where is your school? Near King's Cross. Very well; now we want to know how to get from King's Cross to the Zoological Gardens. Do you know where the Gardens are? In Regent's Park. Who has ever been to the Park? How did you get there? We walked. Yes, you can walk, but it is rather a long way, and it is very much better to ride, then you can play about when you get there without getting tired. Who has ever ridden to Regent's Park? In what did you ride? In an *omnibus*. And you, Tommy? In a *train*. Well, here is one little boy says he went in his father's *cab;* that must have been nice, I am sure. Now is there anything else in which you could ride besides an omnibus, train, or cab? Very well, Mary says her father took them all in his *cart* when they went. When I went to the Zoological Gardens last I saw a great many carriages outside the gates. What were they doing there? Quite right, they were waiting to take away the ladies and gentlemen whom they had brought there. Is there no other means by which we can get from one place to another? Well, if you stand by King's Cross station, you will often see people riding in something else that you have not mentioned. Yes, it is a *tram-car*. What are tram-cars like? Yes, they are something like omnibuses, and James says they are something like trains. In what are they like omnibuses? They are drawn along the streets by horses, and they stop when any one wants to get in. Why did James say they were like trains? Because they run on lines like the trains.

Now, I am quite sure you have all seen gentlemen riding on something that you have not yet mentioned. Well, Mary? I have seen a gentleman on a *tricycle*. And there is something very much like a tricycle; what is that? A *bicycle*. What is the difference between a tricycle and a bicycle? One has three wheels, and the other has two. Yes; it is very easy to remember, because this part of the word means 'wheel' (underlining 'cycle') and 'bi' means 'two'; and 'tri' means 'three,' so that 'bi-cycle' means 'two wheels,' and 'tri-cycle' means 'three wheels.' Haven't you had a word with 'tri' in it before? Yes, 'tri-angle.' What does that mean? The other day I saw a gentleman riding by himself, but it was not on a bicycle or a tricycle. Can you tell me what he was on? He was on a *horse*. We say, he was riding horseback.

Now you shall name for me, and I will write them on the slate, the different means by which we can get from one place to another.

We can walk, we can ride in a train, omnibus, tram-car, cab, carriage, cart, on horseback, tricycle, or bicycle.

II. *Advantages of each.*—Which of all these ways of travelling do you like best? One little girl says she likes going in the train best. Why, Bessie? Because the train goes so quickly. Yes, it does; and if we are in a hurry, we like to go in a train. But does the train go to every place that we want to go to? No, the trains only go to stations, and then we have to walk from the station. If we want to ride all the way, what must we go in? An omnibus. Well, Tommy, what are you going to say? The other day I went to my aunt's in an omnibus, and it did not take me all the way. I had to get out and walk. How was that? Because the omnibus never goes down my aunt's street; it always goes along the end of it. Does the omnibus always go the same way? Yes; all omnibuses go the same way every day; so, unless you are going the way the omnibus goes, you will have to walk

some part of the way. What must we ride in if we want it to go exactly the way we wish? In a cab. Do you often ride in a cab? Why not? Because it costs too much money. Yes; if you go ever such a little way in a cab, you must pay the cabman one shilling; but you can go a very long way in an omnibus for twopence or threepence. Do you know why you can ride so much cheaper in an omnibus? Yes, that is right; a great many people ride in the omnibus, and every person has to pay the man, so that altogether he gets a great deal; but only one person rides in a cab, and he has to pay all the money himself, even if two or three friends are with him. Now, there is something else in which we can ride a very long way for twopence; what is that? Which do you like riding in best? Why do you like the tram best? It goes much more easily. Can the tram go any way we like? Why not? Yes, you remember you told me before, it has lines to run on, just like the train has. It is the lines that make the cars go so easily. Do you know what makes the omnibus shake so much? Yes, it is very often the rough, stony roads that it has to run along. Which is the larger, the tram or omnibus? The tram is much larger. Does it have more horses to draw it? How is it that the two horses are able to draw the large tram along? The lines make it easy for the horses to draw it; they could not draw the car if it were not for the lines. Why?

III. Recapitulation.—Now we have found out that we like riding in cabs, but we cannot do so because they are too dear. Who can ride in cabs? Rich people. In what do very rich people ride? In carriages.

We like riding in tram-cars better than in omnibuses; but sometimes the tram does not go the way we want to go, and then we use the omnibus.

Sometimes we like to go in the train, especially if we are in a hurry, because it goes quickly, and, like the tram and omnibus, it does not cost much money.

Sometimes we are obliged to have a cab, though it is dear. Do you know when that is? Yes, when you are going into the country, you have to take luggage with you, and you have to ride in a cab to the station. Why could you not go in the omnibus? Because we cannot take much luggage in an omnibus. Where does the cabman put the luggage? On the top of his cab. Yes, he can carry a great deal of luggage there.

Section IV.—Common Employments.

LESSON—THE CARPENTER.

Apparatus.—Good picture of carpenter at work, and specimens of the tools used by him. (A child's tool box would supply the necessary specimens.) Six pieces of wood properly prepared to form a box, also a rough piece of wood.

I dare say you remember that we had a long talk about the bricklayer a short time ago, and to-day I want you to tell me about another man who helps the builder build the house.

We said that while the bricklayers are building the walls, some other men come and put in large pieces of wood on which the floors are to be made. What did we call these men? Carpenters. What else do they do? They nail down the floors, and put in the doors, and windows, and the stairs. Of what are all these things made? They are all made of wood. Then what part of the house does the carpenter do? He does all the woodwork. Does he wait until the bricklayers have finished? No; he is obliged to do some of his work at the same time. The teacher should then let the children repeat the parts of the house made by the carpenters while the bricklayers are at work. Now I want you to tell me the names of the tools used by the carpenter, and for what he uses them. The teacher then, pointing to the pieces of wood, would say, What have I here? Some pieces of wood. Yes, and with these we will try to make a box. How many pieces of wood are there? Six pieces. Do you think the carpenter would get his wood like this already to make the box. What would he have to do? He would have a large plank. What would he do to it? He would have to cut it into the right pieces. How would he get the right length, etc., of the pieces? He would measure it. With what does he measure? The teacher should here show the children a rule, and tell them that the carpenter's rule is generally two feet in length, and hence he calls it a *two-foot rule*. The children's attention should also be directed to the way the two-foot rule folds, and the advantage of this pointed out. Now, Harry, come and show how the carpenter measures the wood. Yes; but what must he do before he takes the rule away? He marks the place. With what? A piece of *lead pencil*. See, here is a piece. Is it like those you use? No, it is much thicker. Then what does he do? He cuts it. With what does he cut the wood? With a *saw*. Come and find me the saw. Do you think you could saw the piece of wood? Well, John thinks he can, but I am afraid he will not be able to, for it is rather difficult to use the saw. Which part must he hold? The handle. Do you know what we call this part of the saw (pointing to the teeth)? Of what is it made? It is made of steel. Now, you see John cannot manage the saw very well—that is why I had the wood cut for you. I had to get the carpenter to do it.

Now let us see if we can find out where the different parts go? Quite right, this large piece is the bottom of the box. Yes, there is another piece like it. Where do you think that will go? Very well, then you have the top and bottom of the box. Now, what other parts have you? Two long pieces. Where will they go? They will do for the sides. And where will these short pieces go? They will do for the ends. We have found out the parts of the box. How shall we put them together? Willy says we might *nail* them together. Another boy says we can *screw* them, and Mary says we can *glue* them. They are quite right, we could nail them, or screw them, or glue them, but we are going to join them another way. Look at the edges of these pieces of wood, and tell me what you see. There are little pieces sticking out. And what do you notice on the other pieces? Little pieces cut out. Yes; these edges have been cut like this. Now look, and I will put these edges together. What do you notice? They fit into each other. Then, you see, this is another way of joining wood. We call this *dovetailing*. The teacher might then show the children how the edge of the blackboard is fastened on to the board, *i.e.*, by a *groove* and a *tongue*. A small piece of match-boarding would be a familiar and easy example of this kind of join. The *tenon and mortise* join would be best illustrated by the frame of the cupboard door or the schoolroom door. The names tenon and mortise, of course, would not be mentioned.

Now how do you think the carpenter cuts the wood out for these kinds of joins? Yes, he sometimes uses a small thin saw, and sometimes a chisel. Can you show me the *chisel*? You must be very careful when you touch the chisel, for it is very sharp, and likely to hurt you. Who has seen the carpenter using his chisel? With what does he strike it? With a large wooden hammer. Yes: we call this the *mallet*. Now look at this piece of wood, and tell me the difference between it and the pieces used for the box? It is very rough, and the others are smooth. Could the carpenter make it smooth? How? By planing it. What does he use to do this? A *plane*. Show me the plane. Yes, it is a large piece of wood with a piece of sharp steel in it. See, I have taken it out. What is it like? A wide chisel without a handle. Yes, that is right; and I have seen a chisel used like a plane. Now if we wanted to nail our box together, what should I have used to knock in the nails? A *hammer*. Show me the hammer? Of what is it made? A piece of iron with a wooden handle. How shall we fasten the lid on the box! Do you want it fixed down firmly? No, we want it to open and shut. Well then? We must have some hinges. See, here are the hinges; how shall we put them on to the box? We must screw them on? How? With the *screw-driver*. What must you first do? Make some holes with the *gimlet*.

Did you use the gimlet for the nails? No; but the screws will not go in unless holes are first made. Why would it not do to nail the hinges on? They would not be strong enough. That is right, the nails would get loose, and then the hinges come off. So, you see, the screws hold things more firmly than the nails do. Sometimes when the carpenter is using nails they do not go in the right way, and he is obliged to pull them out again. What does he use for this? The *pincers*. Show me the pincers. What were you going to say, Charlie? He uses the other part of the hammer. Yes; some hammers are made like this one, and we are able to use it to pull out nails. Do you know what we call the table at which the carpenter works? His *bench*. How many of you have seen a carpenter's bench. The children's attention should be directed to picture of the bench, or a little model might easily be obtained for them to see. Now the carpenter does not want to hold his wood still with his hands. Why not? Because he wants his hands to work with. So he puts the wood between these two pieces, and then with these long wooden screws he fastens it very tightly. You told me that the carpenter sometimes fastens the wood together with glue. In what does he have his glue? In the *glue-pot*. See, here is one. There are really two pots, one fitting into the other. In which does the carpenter put the glue? In the inner one. And what does he put in the outer one? Water. Why? To make the glue soft when he puts it on the fire. Yes; the glue would not get soft if he put the inner pot on the fire, it would only burn.

As a recapitulatory exercise the children should write on their slates the names of the tools used by the carpenter, and then name the use of each to the teacher.

The different kinds of joins should be asked for, and the children should also name the different things made by the carpenter.

(To be continued.)

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Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER X.—THE BLOOD—(*continued*).

Cause of Coagulation of Blood.—Many theories have been propounded to explain the clotting of blood after it has been shed, and the immunity from clotting while it remains in the living vessels. It is now certain that the true explanation is the formation of fibrin, from the union of certain substances which did not previously exist as fibrin.

What prevents a similar formation of fibrin in the living organism is uncertain. The existence of warmth, or constant movement, or absence of exposure to air does not explain the immunity from coagulation, as in converse conditions, coagulation may be prevented. Doubtless there is an equilibrium established between the blood-vessels and the blood contained in them, which in some way inhibits the formation of fibrin. This is shown (1) by the facts that, after death, blood remains fluid for a considerable time in the veins, but will coagulate immediately on removal from them; and that blood coagulates earliest in the larger vessels. (2) The same conclusion is confirmed by the fact that a wire introduced into a living blood-vessel becomes coated with fibrin, and forms a centre for extensive clotting. By this method, large swellings of arteries (aneurisms) have occasionally been cured. (3) When the internal coat of a blood-vessel is injured by tying or otherwise, coagulation occurs.

The following experiments reveal the real character of blood coagulation:—

(1) Take a quantity of horse's blood and surround the vessel containing it with a freezing mixture of ice and salt. Clotting is indefinitely postponed, and all the corpuscles settle to the bottom. Remove the liquid plasma from the mixture and it commences to coagulate. It follows that blood-corpuscles are not an essential part of the clot.

(2) Take a portion of fresh blood and whip it sharply with a bundle of small twigs. Fibrin is deposited on the twigs, and the blood remaining in the vessel, although apparently the same, will not clot, however long it is left. The fibrin thus obtained is in minute threads, possessing the general properties of proteids. It is insoluble in water and in dilute saline solutions. Dilute hydrochloric acid causes it to swell up, but not dissolve.

(3) If some of the liquid plasma obtained in the first experiment have sodium chloride or some other neutral salt added to saturation, a white, flaky precipitate appears. If this is removed, the remaining liquid is no longer coagulable. To this precipitate the name of *plasmine* has been given. It can easily be dissolved by a little water, and for a short time remains liquid, soon, however, becoming gelatinous, and finally forming a clot. Inasmuch as plasmine is soluble in water, it cannot be identical with fibrin, and yet it speedily produces fibrin when in solution. Is it, then, a mixture of more than one substance, which tend to combine and form fibrin? That this is the explanation may be confirmed by the following experiments:—

(4) If the fluid from a hydrocele (which is a dropsical accumulation in a serous cavity) be mixed with some serum or whipped blood, coagulation occurs, though neither alone will clot.

(5) If serum be treated to saturation with solid sodium chloride, a precipitate is produced, like plasmine in being readily soluble in water, but unlike it in not coagulating on standing. This material when added to hydrocele fluid causes it to coagulate, and is evidently the material which effected this in the last experiment (4). The same substance may be prepared by diluting blood with from ten to twenty times its bulk of water, and passing a brisk stream of carbonic acid through it. It is named *fibrinoplastin* or *paraglobulin*.

(6) If hydrocele fluid be treated in the same way with carbonic acid or sodium chloride to saturation, a somewhat similar precipitate is obtained, known as *fibrinogen*. When this precipitate has been dissolved in a dilute saline solution, and added to serum, coagulation occurs, while the hydrocele fluid *minus* fibrinogen no longer causes the coagulation of serum.

(7) If precipitated fibrinogen be mixed with precipitated fibrinoplastin, and the two dissolved in dilute saline solution, the fluid mixture will soon coagulate with the production of normal fibrin.

It is evident then that plasmine is a mixture of fibrinoplastin and fibrinogen, and that when these are made to combine fibrin is produced.

There is some evidence of the existence of a third body, favouring coagulation, which only affects the rapidity of coagulation, but not the amount of fibrin produced. This is *fibrin-ferment*, and it is probably owing to the scarcity of this, that when the fibrinogen and fibrinoplastin prepared by the carbonic acid method are mixed, clotting is very difficult or entirely

some part of the way. What must we ride in if we want it to go exactly the way we wish? In a cab. Do you often ride in a cab? Why not? Because it costs too much money. Yes; if you go ever such a little way in a cab, you must pay the cabman one shilling; but you can go a very long way in an omnibus for twopence or threepence. Do you know why you can ride so much cheaper in an omnibus? Yes, that is right; a great many people ride in the omnibus, and every person has to pay the man, so that altogether he gets a great deal; but only one person rides in a cab, and he has to pay all the money himself, even if two or three friends are with him. Now, there is something else in which we can ride a very long way for twopence; what is that? Which do you like riding in best? Why do you like the tram best? It goes much more easily. Can the tram go any way we like? Why not? Yes, you remember you told me before, it has lines to run on, just like the train has. It is the lines that make the cars go so easily. Do you know what makes the omnibus shake so much? Yes, it is very often the rough, stony roads that it has to run along. Which is the larger, the tram or omnibus? The tram is much larger. Does it have more horses to draw it? How is it that the two horses are able to draw the large tram along? The lines make it easy for the horses to draw it; they could not draw the car if it were not for the lines. Why?

III. Recapitulation.—Now we have found out that we like riding in cabs, but we cannot do so because they are too dear. Who can ride in cabs? Rich people. In what do very rich people ride? In carriages.

We like riding in tram-cars better than in omnibuses; but sometimes the tram does not go the way we want to go, and then we use the omnibus.

Sometimes we like to go in the train, especially if we are in a hurry, because it goes quickly, and, like the tram and omnibus, it does not cost much money.

Sometimes we are obliged to have a cab, though it is dear. Do you know when that is? Yes, when you are going into the country, you have to take luggage with you, and you have to ride in a cab to the station. Why could you not go in the omnibus? Because we cannot take much luggage in an omnibus. Where does the cabman put the luggage? On the top of his cab. Yes, he can carry a great deal of luggage there.

Section IV.—Common Employments.

LESSON—THE CARPENTER.

Apparatus.—Good picture of carpenter at work, and specimens of the tools used by him. (A child's tool box would supply the necessary specimens.) Six pieces of wood properly prepared to form a box, also a rough piece of wood.

I dare say you remember that we had a long talk about the bricklayer a short time ago, and to-day I want you to tell me about another man who helps the builder build the house.

We said that while the bricklayers are building the walls, some other men come and put in large pieces of wood on which the floors are to be made. What did we call these men? Carpenters. What else do they do? They nail down the floors, and put in the doors, and windows, and the stairs. Of what are all these things made? They are all made of wood. Then what part of the house does the carpenter do? He does all the woodwork. Does he wait until the bricklayers have finished? No; he is obliged to do some of his work at the same time. The teacher should then let the children repeat the parts of the house made by the carpenters while the bricklayers are at work. Now I want you to tell me the names of the tools used by the carpenter, and for what he uses them. The teacher then, pointing to the pieces of wood, would say, What have I here? Some pieces of wood. Yes, and with these we will try to make a box. How many pieces of wood are there? Six pieces. Do you think the carpenter would get his wood like this already to make the box. What would he have to do? He would have a large plank. What would he do to it? He would have to cut it into the right pieces. How would he get the right length, etc., of the pieces? He would measure it. With what does he measure? The teacher should here show the children a rule, and tell them that the carpenter's rule is generally two feet in length, and hence he calls it a *two-foot rule*. The children's attention should also be directed to the way the two-foot rule folds, and the advantage of this pointed out. Now, Harry, come and show how the carpenter measures the wood. Yes; but what must he do before he takes the rule away? He marks the place. With what? A piece of *lead pencil*. See, here is a piece. Is it like those you use? No, it is much thicker. Then what does he do? He cuts it. With what does he cut the wood? With a *saw*. Come and find me the saw. Do you think you could saw the piece of wood? Well, John thinks he can, but I am afraid he will not be able to, for it is rather difficult to use the saw. Which part must he hold? The handle. Do you know what we call this part of the saw (pointing to the teeth)? Of what is it made? It is made of steel. Now, you see John cannot manage the saw very well—that is why I had the wood cut for you. I had to get the carpenter to do it.

Now let us see if we can find out where the different parts go? Quite right, this large piece is the bottom of the box. Yes, there is another piece like it. Where do you think that will go? Very well, then you have the top and bottom of the box. Now, what other parts have you? Two long pieces. Where will they go? They will do for the sides. And where will these short pieces go? They will do for the ends. We have found out the parts of the box. How shall we put them together? Willy says we might *nail* them together. Another boy says we can *screw* them, and Mary says we can *glue* them. They are quite right, we could nail them, or screw them, or glue them, but we are going to join them another way. Look at the edges of these pieces of wood, and tell me what you see. There are little pieces sticking out. And what do you notice on the other pieces? Little pieces cut out. Yes; these edges have been cut like this. Now look, and I will put these edges together. What do you notice? They fit into each other. Then, you see, this is another way of joining wood. We call this *dovetailing*. The teacher might then show the children how the edge of the blackboard is fastened on to the board, *i.e.*, by a *groove* and a *tongue*. A small piece of match-boarding would be a familiar and easy example of this kind of join. The *tenon and mortise* join would be best illustrated by the frame of the cupboard door or the schoolroom door. The names tenon and mortise, of course, would not be mentioned.

Now how do you think the carpenter cuts the wood out for these kinds of joins? Yes, he sometimes uses a small thin saw, and sometimes a chisel. Can you show me the *chisel*? You must be very careful when you touch the chisel, for it is very sharp, and likely to hurt you. Who has seen the carpenter using his chisel? With what does he strike it? With a large wooden hammer. Yes: we call this the *mallet*. Now look at this piece of wood, and tell me the difference between it and the pieces used for the box? It is very rough, and the others are smooth. Could the carpenter make it smooth? How? By planing it. What does he use to do this? A *plane*. Show me the plane. Yes, it is a large piece of wood with a piece of sharp steel in it. See, I have taken it out. What is it like? A wide chisel without a handle. Yes, that is right; and I have seen a chisel used like a plane. Now if we wanted to nail our box together, what should I have used to knock in the nails? A *hammer*. Show me the hammer? Of what is it made? A piece of iron with a wooden handle. How shall we fasten the lid on the box! Do you want it fixed down firmly? No, we want it to open and shut. Well then? We must have some hinges. See, here are the hinges; how shall we put them on to the box? We must screw them on? How? With the *screw-driver*. What must you first do? Make some holes with the *gimlet*.

Did you use the gimlet for the nails? No; but the screws will not go in unless holes are first made. Why would it not do to nail the hinges on? They would not be strong enough. That is right, the nails would get loose, and then the hinges come off. So, you see, the screws hold things more firmly than the nails do. Sometimes when the carpenter is using nails they do not go in the right way, and he is obliged to pull them out again. What does he use for this? The *pincers*. Show me the pincers. What were you going to say, Charlie? He uses the other part of the hammer. Yes; some hammers are made like this one, and we are able to use it to pull out nails. Do you know what we call the table at which the carpenter works? His *bench*. How many of you have seen a carpenter's bench. The children's attention should be directed to picture of the bench, or a little model might easily be obtained for them to see. Now the carpenter does not want to hold his wood still with his hands. Why not? Because he wants his hands to work with. So he puts the wood between these two pieces, and then with these long wooden screws he fastens it very tightly. You told me that the carpenter sometimes fastens the wood together with glue. In what does he have his glue? In the *glue-pot*. See, here is one. There are really two pots, one fitting into the other. In which does the carpenter put the glue? In the inner one. And what does he put in the outer one? Water. Why? To make the glue soft when he puts it on the fire. Yes; the glue would not get soft if he put the inner pot on the fire, it would only burn.

As a recapitulatory exercise the children should write on their slates the names of the tools used by the carpenter, and then name the use of each to the teacher.

The different kinds of joins should be asked for, and the children should also name the different things made by the carpenter.

(To be continued.)

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Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER X.—THE BLOOD—(*continued*).

Cause of Coagulation of Blood.—Many theories have been propounded to explain the clotting of blood after it has been shed, and the immunity from clotting while it remains in the living vessels. It is now certain that the true explanation is the formation of fibrin, from the union of certain substances which did not previously exist as fibrin.

What prevents a similar formation of fibrin in the living organism is uncertain. The existence of warmth, or constant movement, or absence of exposure to air does not explain the immunity from coagulation, as in converse conditions, coagulation may be prevented. Doubtless there is an equilibrium established between the blood-vessels and the blood contained in them, which in some way inhibits the formation of fibrin. This is shown (1) by the facts that, after death, blood remains fluid for a considerable time in the veins, but will coagulate immediately on removal from them; and that blood coagulates earliest in the larger vessels. (2) The same conclusion is confirmed by the fact that a wire introduced into a living blood-vessel becomes coated with fibrin, and forms a centre for extensive clotting. By this method, large swellings of arteries (aneurisms) have occasionally been cured. (3) When the internal coat of a blood-vessel is injured by tying or otherwise, coagulation occurs.

The following experiments reveal the real character of blood coagulation:—

(1) Take a quantity of horse's blood and surround the vessel containing it with a freezing mixture of ice and salt. Clotting is indefinitely postponed, and all the corpuscles settle to the bottom. Remove the liquid plasma from the mixture and it commences to coagulate. It follows that blood-corpuscles are not an essential part of the clot.

(2) Take a portion of fresh blood and whip it sharply with a bundle of small twigs. Fibrin is deposited on the twigs, and the blood remaining in the vessel, although apparently the same, will not clot, however long it is left. The fibrin thus obtained is in minute threads, possessing the general properties of proteids. It is insoluble in water and in dilute saline solutions. Dilute hydrochloric acid causes it to swell up, but not dissolve.

(3) If some of the liquid plasma obtained in the first experiment have sodium chloride or some other neutral salt added to saturation, a white, flaky precipitate appears. If this is removed, the remaining liquid is no longer coagulable. To this precipitate the name of *plasmine* has been given. It can easily be dissolved by a little water, and for a short time remains liquid, soon, however, becoming gelatinous, and finally forming a clot. Inasmuch as plasmine is soluble in water, it cannot be identical with fibrin, and yet it speedily produces fibrin when in solution. Is it, then, a mixture of more than one substance, which tend to combine and form fibrin? That this is the explanation may be confirmed by the following experiments:—

(4) If the fluid from a hydrocele (which is a dropsical accumulation in a serous cavity) be mixed with some serum or whipped blood, coagulation occurs, though neither alone will clot.

(5) If serum be treated to saturation with solid sodium chloride, a precipitate is produced, like plasmine in being readily soluble in water, but unlike it in not coagulating on standing. This material when added to hydrocele fluid causes it to coagulate, and is evidently the material which effected this in the last experiment (4). The same substance may be prepared by diluting blood with from ten to twenty times its bulk of water, and passing a brisk stream of carbonic acid through it. It is named *fibrinoplastin* or *paraglobulin*.

(6) If hydrocele fluid be treated in the same way with carbonic acid or sodium chloride to saturation, a somewhat similar precipitate is obtained, known as *fibrinogen*. When this precipitate has been dissolved in a dilute saline solution, and added to serum, coagulation occurs, while the hydrocele fluid *minus* fibrinogen no longer causes the coagulation of serum.

(7) If precipitated fibrinogen be mixed with precipitated fibrinoplastin, and the two dissolved in dilute saline solution, the fluid mixture will soon coagulate with the production of normal fibrin.

It is evident then that plasmine is a mixture of fibrinoplastin and fibrinogen, and that when these are made to combine fibrin is produced.

There is some evidence of the existence of a third body, favouring coagulation, which only affects the rapidity of coagulation, but not the amount of fibrin produced. This is *fibrin-ferment*, and it is probably owing to the scarcity of this, that when the fibrinogen and fibrinoplastin prepared by the carbonic acid method are mixed, clotting is very difficult or entirely

absent. The action of *neutral salts* is somewhat doubtful, but their presence seems to be essential for the occurrence of coagulation.

The condition in which fibrinogen and fibrinoplastin exist in blood is still very doubtful. Some of the fibrin-factors, probably, originate in the white corpuscles; as under the microscope, coagulation is seen to be preceded by the breaking up of white corpuscles. It has been suggested that fibrinogen is constantly present in the blood, and that fibrinoplastin and fibrin-ferment are produced by the disintegration of the white corpuscles. But even if this is correct, part of the subject still remains unsolved; for many corpuscles must die and break up in the blood, and yet no coagulation occurs. The supposition of an inhibitory power of the blood-vessels still remains necessary.

CHAPTER XI.

CIRCULATION OF THE BLOOD.

General view of Circulation.—It will be convenient first to give a general description of the blood circulation, entering into the details of its mechanism after describing the anatomy of the circulatory organs.

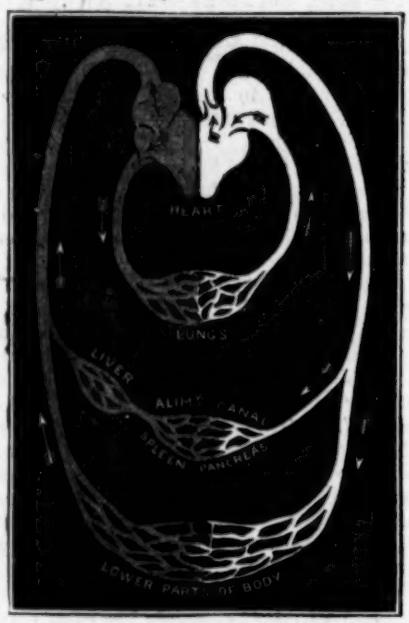

Fig. 42.—Theoretical diagram of the Circulation. The darker-shaded part shows the venous blood.

The heart contains four cavities, the two on one side not communicating directly with those on the other. Supposing a drop of blood to be in the superior or inferior vena cava. It passes thence into the right auricle (Fig. 42), and is carried through the orifice between the auricle and ventricle into the right ventricle. The valves placed between these prevent any reflux of blood, and on contraction of the heart, it is forced into the pulmonary artery. By this it is carried to the lungs, being distributed to the pulmonary capillaries and returning greatly purified along the pulmonary veins, which empty it into the left auricle. The contraction of the auricle drives it into the left ventricle, and on contraction of the latter it is sent into the aorta. Its subsequent course varies with circumstances. It may be carried to the head, or limbs, or trunk, being distributed by capillaries, which return the blood by the superior and inferior vena cava to the right auricle. A certain portion of it, however, takes a more complicated course. After being distributed to the alimentary canal and spleen, the veins from these parts do not empty directly into the inferior vena cava, but join to form the portal vein, which breaks up into capillaries in the liver, then forms the hepatic vein, which empties into the inferior vena cava.

It will be seen that there are two circuits or circulations performed by the blood, a lesser or *pulmonary circulation*, and a greater or *systemic circulation*. That part of the systemic circulation which passes through the liver is known as the *portal circulation*.

Fig. 43.—Theoretical section of Heart, showing the four cavities and origin of large vessels.
(*a*) Aorta; (*bb*) Pulmonary arteries, arising from a common trunk; (*c*) Superior vena cava; (*dd*) Right and left pulmonary veins; (*f*) Right auricle; (*g*) Left auricle; (*h*) Inferior vena cava; (*i*) Right ventricle; (*k*) Left ventricle; (*l*) Inter-ventricular septum.

(*To be continued.*)

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ANSWERS TO
Pupil Teachers' Examination Papers.
AUGUST 30TH, 1884.
FIRST YEAR.
Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Find the least number that is divisible by 5, 6, 7, 8, 9, and 10, and leaves in each case the remainder 4.

No. = L.C.M. of 5, 6, 7, 8, 9, 10, + 4.

$$\begin{array}{r} 2)\overline{5,\ 6,\ 7,\ 8,\ 9,\ 10} \\ \overline{5,\ 7,\ 4,\ 9,\ 5} \end{array}$$

$(2\times7\times4\times9\times5)+4=2524$. Ans.

2. What fraction is $3\frac{3}{5}$ of $1\frac{1}{2}\frac{3}{3} - \frac{3}{8}$, of $4\frac{1}{8} + 2\frac{1}{10}$ of $7\frac{1}{2}$?

$$\frac{3\frac{3}{5}\text{ of }1\frac{1}{2}\frac{3}{3} - \frac{3}{8}}{4\frac{1}{8} + 2\frac{1}{10}\text{ of }7\frac{1}{2}} = \frac{\frac{18}{5}\times\frac{47}{33} - \frac{3}{8}}{\frac{33}{8} + \frac{11}{10}\times\frac{15}{2}}$$

$$= \frac{\frac{282}{55} - \frac{3}{8}}{\frac{33}{8} + \frac{33}{4}} = \frac{\frac{324 - 40}{440}}{\frac{50 + 189}{40}} = \frac{45}{12}$$

$$= \frac{284}{440}\times\frac{40}{239} = \frac{284}{1166}$$. Ans.

3. Express ·4875 of a guinea as the decimal of 12s. 6d.; and find in yards the value of ·327 of a mile.

$$\frac{\text{·4875 of 21s.}}{\text{12s. 6d.}} = \frac{10\text{·}2375}{12\text{·}5} = \text{·819}.$$ Ans.

·327 of 1760 yds.

$$= \frac{327 - 3}{990}\times\frac{1760}{1}$$

$$= \frac{324}{990}\times\frac{1760}{1}$$

$$= 576\text{ yds.}$$ Ans.

4. *A* can do a piece of work in 10 days, and *B* can do it in 8 days. After *A* has worked 3 days, in how many days will *A* and *B* together finish the remainder?

A can do $\frac{1}{10}$ in a day; *B* can do $\frac{1}{8}$;

A and *B* $\frac{1}{10} + \frac{1}{8} = \frac{4+5}{40} = \frac{9}{40}$.

Amount done by *A* alone $= \frac{3}{10}$,

„ left to be done by *A* and *B* $= \frac{7}{10}$.

		day.	days.
∴	$\frac{9}{40}$:	$\frac{7}{10}$ ::	1 : x

$= \frac{40}{9} \times \frac{7}{10}$

$= 3\frac{1}{2}$ days. Ans.

FEMALES.

1. How much money will be required to pay the following bill:—

			£	s.	d.
19	lbs. of beef at 11d. per lb.	=	0	17	5
$13\frac{1}{2}$	„ mutton at 9d. per lb.	=	0	9	$11\frac{1}{2}$
$9\frac{1}{2}$	„ mutton at $9\frac{1}{2}$d. per lb.	=	0	7	$6\frac{1}{2}$
$6\frac{1}{2}$	„ lamb at 11d. per lb.	=	0	6	$2\frac{1}{2}$
$17\frac{1}{2}$	„ beef at 10d. per lb.	=	0	14	$4\frac{1}{2}$
$3\frac{1}{2}$	„ suet at $8\frac{1}{2}$d. per lb.	=	0	2	$5\frac{1}{2}$
	Amount required	=	£2	17	11

2. Find the Greatest Common Measure of 169037 and 66429; and the Least Common Multiple of 44, 48, 52, and 96. What do you mean by *Measure* and a *Multiple*?

66429)169037(2
132858
36179)66429(1
etc., etc.

G.C.M. = 121. Ans.

4)44, 48, 52, 96
11. 13, 24

L.C.M. = 4 × 11 × 13 × 24 = 13,728. Ans.

A *Measure* is any number which will divide another without a remainder; thus 6 is a measure of 24.

A *Multiple* is a number which contains another an equal number of times, thus 24 is a multiple of 6.

3. Add together $\frac{7}{10}$ $5\frac{3}{8}$, $\frac{5}{16}$, and $3\frac{13}{16}$.

$= 8\frac{21+32+5+38}{48}$

$= 8\frac{24}{48}$

$= 10$. Ans.

4. Find the cost of 25 acres 1 rood 10 poles at £42 2s. 4d. per acre.

	£	s.	d.	
1 r. = $\frac{1}{4}$ of 1 a.	42	2	4	= Cost of 1 acre.
			25	
	1052	18	4	= „ 25 acres.
10 p. = $\frac{1}{4}$ of 1 r.	10	10	7	= „ 1 rood.
	2	12	$7\frac{1}{2}$	= „ 10 poles.
	£1066	1	$6\frac{1}{2}$	= cost of 25 a. 1 r. 10 p.

Grammar.

MALES AND FEMALES.

1. *Toll* for the *Brave!*
Brave Kempenfelt is *gone*,
His *last sea-fight* is *fought*;
His work of glory *done*.

Analyse these lines and parse the words in italics.

Sentence.	Kind of Sent.	Subject.	Predicate.	Object.	Extension.
(*a*) Toll for the Brave	P. S.	[you]	toll	for the Brave (ind.)	
(*b*) Brave Kempenfelt is gone	P. S.	Brave Kempenfelt	is gone		
(*c*) His last sea-fight is fought	P. S.	His last sea-fight	is fought		
(*d*) His work of glory done	P. S.	His work of glory	[is] done		

Toll—Reg. int. verb, act., imp., pres., 2nd, plur., agreeing with its nom. *you* und.
Brave—an adj. of quality, used as a com. noun, masc., plur., obj., gov. by *for*.
brave—adj. of quality, qualifying *Kempenfelt*.
is—aux. verb to *gone*, used instead of *has*, to indicate perfect tense.
gone—past part. of the verb *to go*, referring to *he*.
is gone—irreg. intr. verb, act., ind., perf., 3rd, sing., agreeing with its nom. *he*.
last—adj. of number, ordinal, qual. *sea-fight*.
sea-fight—comp. com. noun, neut., sing., nom. to *is fought*.
fought—past part. of *to fight*, referring to *sea-fight*, forming with *is* the pres. ind., 3rd, sing., pass. of *to fight*.
his—pers. pro., masc., sing., 3rd, poss., gov. by *work*.
done—past part. of *to do*, referring to *work*, forming with *is* the pres. ind., 3rd, sing., pass. of *to do*.

2. Explain the use of the adjective 'brave' in the first line and give similar instances.

'Brave' in the first line of the verse is an adjective, used as a noun. It stands instead of a noun which would include all those who perished in the foundering of the ship, of which Kempenfelt was the commander.

Other examples. We honour the Good. He loves the Beautiful. Punishment awaits the Wicked.

3. Write out the past indefinite tense of each of the verbs, 'toll,' 'go,' 'do,' 'fight.'

Toll (Past Indefinite).

1. I tolled	1. We tolled
2. Thou tolledst	2. You tolled
3. He tolled	3. They tolled

Go (Past Indefinite).

1. I went	1. We went
2. Thou wentest	2. You went
3. He went	3. They went

Do (Past Indefinite).

1. I did	1. We did
2. Thou didst	2. You did
3. He did	3. They did

Fight (Past Indefinite).

1. I fought	1. We fought
2. Thou foughtest	2. You fought
3. He fought	3. They fought

Geography.

(*Answer two Questions.*)

1. Draw a map of the West Coast of Ireland, with the names of the capes and inlets.

2. Give an account of the mountain system of Scotland.

Scotland is a mountainous country, especially in the N. and W. The principal ranges of mountains lie parallel with each other, and stretch across the country from NE. to SW.

The three chief ranges are (1) The Lowthers and Cheviots, (2) The Grampians, (3) The Northern Highlands.

(1) The Cheviots form part of the boundary between England

and Scotland, and the Lowthers separate Dumfries from Peebles and Lanark.

(2) The Grampians stretch across Perth and Inverness. They contain Ben Nevis, the highest Scottish mountain (4368 feet), and many peaks almost as high, as Ben More, Ben Ledi, Ben Lawers, Ben Macdhui, Ben Cruachan, Schiehallion, and Lochnagar.

(3) The Northern Highlands lie north and west of the Caledonian Canal. They form a great plateau. The chief heights are Ben Wyvis, Ben Attow, and Ben More.

3. Name the principal lakes in British North America, and the rivers with which they are connected.

The principal lakes in British N. America are Superior, Huron, Erie, and Ontario, in the basin of the River St. Lawrence; Athabasca, Great Slave, and Great Bear Lakes, in the basin of the Mackenzie River; and Lake of the Woods, L. Winnipeg, L. Winnipegos, Deer Lake, and L. Wollaston, connected by the River Nelson with Hudson Bay.

History.

1. How often did Julius Cæsar visit Britain? Give some account of the Roman invasion under him.

Twice: first in 55 B.C.; second in 54 B.C. Julius Cæsar was Governor of Gaul, and finding that the Gauls had received help from Britain, he invaded the island to punish the inhabitants in 55 B.C. He came with two legions, and landed at Walmer or Deal, after a sharp fight with the natives. After being in the island a fortnight, his fleet was partially destroyed by a storm, and he thought it prudent to return to Gaul. He invaded Britain the following year with five legions (30,000), and 2,000 horse. The Britons were led by Cassivelaunus. Cæsar followed them on their retreat across the Thames to the West of London, and attacked the fortified camp of their leader. As the Kentish people were unable to render Cassivelaunus any help, he was compelled to make terms with Cæsar, who took hostages, settled the amount of tribute, and returned to Gaul.

2. Mention some of the principal events connected with the Saxon conquest of this country.

On the decline of the Roman power in Britain, the Picts and Scots invaded England, and the Teutonic tribes from the Elbe and district ravaged the coasts. Both these enemies were driven back by the Roman general, Theodosius, in 367. When the Romans left Britain (410), these enemies returned, the Britons unsuccessfully coped with the Picts and Scots, and, it is said, their chief, Vortigern, got the aid of Hengest and Horsa, who turned against him, and took the land for themselves and their friends. For nearly 100 years tribes of Jutes, Angles, and Saxons arrived, the Britons were driven further and further westward, till they occupied only Wales and Cornwall. King Arthur is spoken of as their chief opponent. He is stated to have been slain in 542. The Saxons established eight separate and independent kingdoms, the chiefs of which were continually at war. Ultimately these were united under Egbert. The introduction of Roman Christianity took place in 596.

3. Write a list of the names and dates of our Danish kings, and describe the dominions of the most famous of them.

	A.D.	A.D.
Sweyn ...	1013—	1014.
Canute ...	1017—	1035.
Harold ...	1035—	1040.
Hardicanute	1040—	1042.

The most famous of these Danish kings was Canute. He ruled over Norway, Sweden, Denmark, and England, besides some say) receiving the homage of the King of Scotland.

Composition.

Write from memory the substance of the passage read to you by the Inspector. The passage was as follows:—

Pope Pius the Second had a little white puppy of eleven months old, of which he was very fond, and which he called Musetta. One day as the Pope was sitting in the Vatican garden, transacting business, Musetta clambered up the side of a water cistern and tumbled in. The Pope's ear caught the piteous tone of her bark, and he sent his attendants to look after her. They rescued her, and brought her back to him. Next day, in the same garden, a big monkey broke loose and worried Musetta nearly to death. The Pope prophesied that his favourite was not destined to enjoy a long life; and, in fact, ten days afterwards the luckless Musetta, sitting in an open window at a great height above the ground, was blown out by a sudden gust of wind and killed. The Pope moralised to his attendants: 'Let men learn from the fortunes of beasts. We may escape twice, but the third peril is fatal. Amend your lives before the third call comes.'

Needlework.

FEMALES.

One hour will be allowed for this exercise in the afternoon.

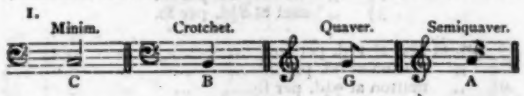
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

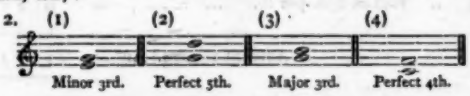
1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name (C, D, E, &c.):—

1.

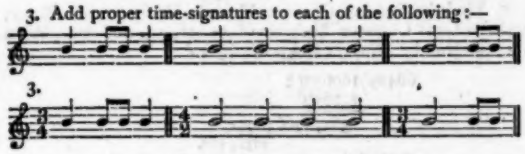


2. Write below each of the following intervals its name (major third, &c.):—

2.



3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write a nine-pulse tone, using three-pulse measures.

1. |d :—:—|—:—:—|—:—:—‖

2. Write the names of the following intervals:—(1) *me* to *soh*; (2) *soh* to *ray*^{1}; (3) *soh* to *te*; (4) *doh* to *fah*.

2. (1) Minor 3rd; (2) Major or Perfect 5th; (3) Major 3rd; (4) Perfect 4th.

3. Write the following an octave higher:—

	m	d	m	s	l	s	m
3.	m^1	d^1	m^1	s^1	l^1	s^1	m^1

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. Define *superficies, right angle, term or boundary, scalene triangle, rhombus, parallel straight lines*, and write out the axiom which may be regarded as the definition of geometrical equality.

A *superficies* is that which has only length and breadth. When a straight line standing on another makes the adjacent angles equal to one another, each of the angles is called a *right angle*.

A *term or boundary* is the extremity of anything.
A *scalene triangle* is that which has three unequal sides.
A *rhombus* is a four-sided figure, which has all its sides equal, but its angles are not right angles.
Parallel straight lines are such as are in the same plane, and which, being produced ever so far both ways, do not meet.
Axiom 8.—Magnitudes which coincide with one another, that is, which fill exactly the same space, are equal to one another.

2. Upon the same base, and on the same side of it, there cannot be two triangles that have their sides which are terminated in one extremity of the base, equal to one another, and likewise those which are terminated in the other extremity.

Euclid, Book I., Prop. 7.

3. If from the ends of a side of a triangle, there be drawn two straight lines to a point within the triangle; these shall be less than the other two sides of the triangle, but shall contain a greater angle.

Euclid, Book I., Prop. 21.

Arithmetic.

FEMALES.

1. Simplify:—(*a*) $\frac{1}{1+\frac{1}{1+\frac{1}{2}}}$; (*b*) $\frac{3}{4}+\frac{1}{6}$ of $\frac{3}{10}-\frac{3}{11}$.

(*a*)
$$\frac{1}{1+\frac{1}{1+\frac{1}{2}}}$$
$$=\frac{1}{1+\frac{1}{1\frac{1}{2}}}$$
$$=\frac{1}{1+\frac{2}{3}}$$
$$=\frac{1}{\frac{5}{3}}$$
$$=\frac{3}{5}. \text{ Ans.}$$

(*b*)
$$\frac{3}{4}+\frac{1}{6} \text{ of } \frac{3}{10}-\frac{3}{11}$$
$$=\frac{3}{4}+\frac{1}{6}-\frac{3}{11}$$
$$=\frac{18+7-4}{42}$$
$$=\frac{21}{42}$$
$$=\frac{1}{2}. \text{ Ans.}$$

2. Reduce $\frac{3}{17}$ of $6\frac{1}{2}$ of £3 5s. 0d. to the fraction of £4 17s. 6d.

$$\frac{3}{17} \text{ of } 6\tfrac{1}{2} \text{ of } £3\ 5s.$$
$$£4\ 17s.\ 6d.$$
$$=\frac{\frac{3}{17}\times\frac{13}{2}\times\frac{1}{5}}{\frac{19}{4}}$$
$$=\frac{3}{17}\times\frac{13}{5}\times\frac{1}{4}\times\frac{4}{19}$$
$$=\frac{3}{85}. \text{ Ans.}$$

3. What do you mean by a *Prime* number? Write down the prime numbers between 90 and 100, and resolve 24 and 42 into prime numbers.

A *Prime number* is one which can be equally divided only by itself and unity.

97 is the only prime number between 90 and 100.
$24=2\times2\times2\times3$
$42=3\times2\times7$. Ans.

4. Convert $\frac{1}{64}$ and $3\frac{11}{125}$ as decimals.

$\frac{1}{64}=.015625$. Ans.

$3\frac{11}{125}=3\frac{11\times8}{125\times8}=\frac{176}{25}=\frac{704}{100}=.00704$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following from the words 'then burst his mighty heart,' and parse the words in italics:—

For when the noble Cæsar saw him *stab*,
Ingratitude, more strong than *traitors'* arms,
Quite vanquished him: then *burst* his mighty *heart*,
And in his mantle muffling *up* his face,
Even at the base of Pompey's statua,
Which all the while ran blood, great Cæsar *fell*.
—'JULIUS CÆSAR.'

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(*a*) Then burst his mighty heart,	Princ. Sent.		His mighty heart	burst		then (*time*)
(*b*) And in his mantle muffling up his face, even at the base of Pompey's statua, great Cæsar fell.	P.S. co-ord. with (*a*)	And	great Cæsar muffling up his face in his mantle	fell		even at the base of Pompey's statua (*place*)
(*c*) Which all the while ran blood.	Adj. to *statua* in (*b*)	*In rel.*	which	ran	[with] blood (ind.)	all the while (*time*)

PARSING.

Stab—Irreg. trans. verb, act., inf., pres., gov. by *saw*.
ingratitude—abs. noun, neut., sing., nom. to *vanquished*.
traitors'—com. noun, masc., plur., poss., gov. by *arms*.
quite—adv. of manner, qual. *vanquished*.
vanquished—reg. trans. verb., act., ind., past, 3rd, sing., agreeing with its nom. *ingratitude*.
burst—irreg. intrans. verb, act. or middle voice, ind., past, 3rd, sing., agreeing with *heart*.
heart—com. noun, neut., sing., nom. to *burst*.
up—adv. of manner, qual. *muffling*.
which—rel. pro., neut., sing., 3rd, agreeing with its antecedent *base*, and nom. to *ran*.
all—adj. of quantity, qual. *while*.
the—adj. of distinction, limiting *while*.
while—= time, adv. used as a noun, neut., sing., obj., gov. by *during* understood.
ran—irreg. intrans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *which*.
blood—com. noun, neut., sing., obj., gov. by *with* understood.
fell—irreg. intrans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *Cæsar*.

2. Point out and explain the force of the adjective suffixes in the following:—

At which time would I, being but a moonish youth, grieve, be effeminate, changeable, proud, fantastical, apish, shallow, inconstant, full of tears, full of smiles.—SHAKESPEARE.

ish in *moonish*, a little like, rather so.
ate in *effeminate*, having the quality of.
able in *changeable*, that may or can be.
ical in *fantastical*, having the quality of.
ish in *apish*, like, rather like, having the nature or quality of.
ow in *shallow*, like: lit. meaning, like a shelf.
ant in *inconstant*, the participle ending of the word, denoting quality.

3. Paraphrase the following:—

Music the fiercest grief can charm,
And fate's severest rage disarm;
Music can soften pain to ease,
And make despair and madness please;
Our joys below it can improve,
And ante-date the bliss above.

"The power of music over the human heart is almost unbounded. Under its influence the deepest sorrow is assuaged, the deepest feeling of misfortune is forgotten, and anguish and madness lose their terrors; it helps to increase and render more deep our earthly joys, and thus enables us to anticipate the happiness awaiting us after death.

Geography.

(*Answer two Questions.*)

1. Draw a map of Switzerland, marking the lakes and rivers.

2. Describe the mountains of British India.

The chief range of mountains in India is the Himalaya range,

which stretches across the whole of the north of the peninsula, and is the highest in the world.

The table-land of Thibet is very high, and the slope of the Himalayas is longest on its north side. On the south it descends abruptly to the plain of Hindostan.

The Solyman range of mountains separating India from Afghanistan and Beloochistan also has its abrupt slope towards India, the plain of the Indus lying at the foot.

Crossing the plain of the Ganges the country again rises into the Vindhya range, and further south the Sautpoora mountains forming the base of the triangular part of India. The centre is occupied by a large table-land, the other two sides being bounded by the East and West Ghauts. The Ghauts terminate in one range, lofty and rugged, called the Neilgherries. The Eastern Ghauts are lower, and more broken than the Western, through which there is not a single opening to the coast for hundreds of miles.

3. What are the climate and productions of the Colony of Victoria?

The climate of Victoria is temperate, resembling in many respects that of Great Britain, except that it is drier and warmer. The average rainfall is similar to that of England, but it occurs during the rainy season, and as it falls on a soil which does not readily absorb it, there are frequent floods in the rivers, and drought and scarcity at other periods.

The climate is mild enough for grapes, oranges, and other semi-tropical fruits to be grown in the open air.

The chief productions of Victoria are gold, copper, iron, coal, wool, hides, wheat, wine, and timber.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a draper by selling cloth at 3s. 4d. a yard gains 8 per cent., what per cent. will he gain by selling it at 3s. 6d. a yard?

Selling price of 100 to gain 8 per cent. = 108.

s. d. s. d.

∴ 3 4 : 3 6 :: 108 : S.P.

$$= \frac{108 \times 42}{40}$$

$$= 113\tfrac{2}{5}$$

∴ Gain = $113\tfrac{2}{5} - 100 = \underline{13\tfrac{2}{5}}$. Ans.

2. What sum of money will amount to £1414 12s. 6½d. in 3½ years at 3¾ per cent. per annum simple interest?

£100 will amount to $100 + 3\tfrac{1}{2} \times 3\tfrac{3}{4} = 113\tfrac{1}{8}$ in a year.

£ £ s. d.

∴ $113\tfrac{1}{8}$: 1414 12 $6\tfrac{1}{2}$ :: 100 : Princ.

$= \underline{£1250\ 10s.}$ Ans.

3. A man had £5000 stock in the 3 per cents., and he sold out at 101½, and invested the proceeds in 5½ per cent. debentures at 137½. Find the increase in his income, brokerage being omitted.

£5000 in 3 per cents. produces $\frac{5000 \times 3}{100} = £150$.

The sale of £5000 produces $\frac{5000 \times 101\frac{1}{2}}{100} = £5075$.

£5075 invested in 5½ per cents at 137½ produces

$$\frac{5075 \times 5\frac{1}{2}}{137\frac{1}{2}} = £203.$$

Change in income = £203 − £150 = $\underline{£53}$. Ans.

4. A, B, and C, each earn 4s. 6d. a day when at work, and nothing when idle, and the average earnings of the three together was 11s 3d. a day for 12 days. If A was idle 2 days, and B 3 days, how many days was C idle?

		£	s.	d.
Total earnings = 11s. 3d. × 12 =		6	15	0
Earnings of A for 10 days = 4s. 6d. × 10 = £2	5	0		
,, B ,, 9 ,, = 4s. 6d. × 9 =	2	0	6	
,, A and B =		4	5	6
∴ ,, C =		£2	9	6

Which at 4s. 6d. per day = $\frac{49s.\ 6d.}{4s.\ 6d.}$ = 11 days.

∴ C was idle 12 − 11 = $\underline{1\ day.}$ Ans.

History.

MALES AND FEMALES.

1. When did William of Normandy conquer England? Give an account of the great battle which he won.

In 1066, Harold had defeated Tostig, and was holding a feast at York, when news arrived that William had landed. This he would not have accomplished if Harold's army in the south had not been disbanded. When the rival armies met, the English occupied a good position on rising ground at Senlac, near Hastings. The impatience of some of the English troops lost the battle. They left their entrenchments to pursue a foe who only pretended flight, and their position was not again successfully attained. The English were also put into confusion by the Normans shooting arrows into the air so as to alight on the heads of their enemies. When Harold had been shot by an arrow, the victory was completed by the slaying of his household troops. Battle Abbey was erected by William to commemorate the victory.

2. How was Scotland treated by our Edwards? What efforts to obtain independence were made by the Scotch?

Edward I. claimed fealty from the Scottish king, and received it from Baliol, who afterwards rebelled. In 1296 Edward took possession of Scotland. Under Wallace the English were defeated at Stirling, but were successful at Falkirk, and Wallace was hanged at Tyburn. Robert Bruce then assumed the crown. Edward's illness and death prevented the re-conquest of the country. Edward II. attempted it, but was defeated at Bannockburn, 30,000 English being slain. Edward III.'s reign began with a Scottish invasion, but he was never able to come near them with his army, so peace was made with them in 1328, one clause of which was that Edward should give up the claim to feudal superiority over the country. Later in his reign the Scots were defeated, and their King, David, taken prisoner at Neville's Cross in Durham. Scotland was entirely independent under Edward IV., V., and VI.

3. How did Henry IV. gain the throne? What opposition was made to him in Wales?

Henry had been banished by Richard II. after his quarrel with the Duke of Norfolk. On the death of his father, John of Gaunt, the whole of his possessions were taken by the King. Henry, with a number of followers, returned to claim them; and on landing in Yorkshire was joined by the people to the extent of 60,000 men. Richard feebly maintained his claim, was taken prisoner by Henry, and in London was formally deposed. Henry then claimed and received the crown.

The Welsh had loved Richard, and they rose in rebellion against Henry. Owen Glendower led them, and ravaged the western counties. Henry in vain attempted to overcome them as they retreated to the mountains. Glendower was afterwards assisted by the Percys of Northumberland and by the French, but his power was broken by the Prince of Wales, although Glendower never formally submitted.

Teaching.

To what points would you call the attention of an upper class in writing the following copy:—

Egypt is watered by the Nile.

First draw attention to the capital *E*, and show its chief forms. Next direct attention to the fact that there are letters of different heights in the copy, *d*, *b*, and *l* being a height above the line, and *t* only half a height. Then pay particular attention to the looping of the *g* and *y*, and by pattern on the blackboard show that *spacing* must be carefully preserved to make the first word *Egypt* look neat. Notice the necessity of care also in making the capital of the last word.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

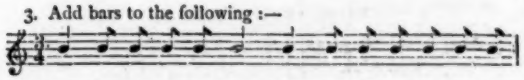
1. Write below each of the following intervals its name (major third, &c.) :—

1.

2. Write the scale of E major, placing the necessary sharps before the notes to be sharpened.

2.

3. Add bars to the following :—



3.

TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—(1) *te* to *doh*^{1} ; (2) *me* to *doh*^{1} ; (3) *doh* to *lah*.

1. (1) Minor 2nd ; (2) Minor 6th ; (3) Major 7th.

2. What is the mental effect (1) of *me* ; (2) of *soh* ?

2. (1) calm and steady ; (2) grand and bright.

3. Write (1) the pulse-signs for a four-pulse measure ; (2) a six-pulse measure.

3. (1) | : | : ‖ (2) | : : | : : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

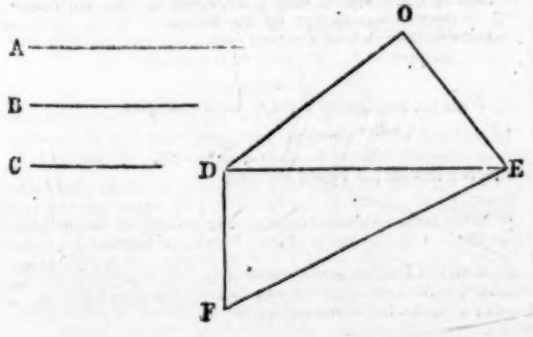
1. If a straight line fall upon two parallel straight lines it makes the alternate angles equal to one another ; and the exterior angle equal to the interior and opposite upon the same side ; and likewise the two interior angles upon the same side together equal to two right angles.

Euclid, Book I., Prop. 29.

2. Parallelograms upon equal bases and between the same parallels are equal to one another.

Euclid, Book I., Prop. 36.

3. Find a square equal to the sum of three given squares, and hence show how to find a square equal to the sum of any number of given squares.



Let A, B, C be three given straight lines.

It is required to describe a square = the sqs. on A, B, and C.

Make OD = A. From point O draw OE = B, and at right ∠'s to OD. Join DE.

Then (I. 47) sq. on DE = sqs. on DO and OE, that is, to sqs. on A and B.

From point D draw DF at right ∠'s to DE and = C. Join FE.

Then (I. 47) sq. on FE = sqs. on FD and DE ; that is, to sqs. on C, A, and B.

Hence, by placing the sides of two sqs. at right ∠'s, a sq. may be described = to them ; by placing the side of *that* sq. at right ∠'s with the side of a third sq., a square may be described equal to three sqs., and so on for any number of squares.

Algebra.

(*Answer two Questions, including No. 2, if you can.*)

1. Find the value of—

$$\frac{30a^2+11ab-28b^2}{6a+7b}-\frac{4a^4b^4+1}{2a^2b^2-2ab+1} \text{ when } a=4,\ b=-3.$$

$$\frac{30a^2+11ab-28b^2}{6a+7b}-\frac{4a^4b^4+1}{2a^2b^2-2ab+1}$$

$$=\frac{30\times16+11\times-12-28\times9}{6\times4+7\times-3}-\frac{4\times256\times81+1}{2\times16\times9-2\times-12+1}$$

$$=\frac{480-132-252}{24-21}-\frac{82945}{313}$$

$$=\frac{96}{3}-265$$

$$=32-265$$

$$=\underline{-233}. \text{ Ans.}$$

2. *Prove* that $\frac{a}{b}\times c=\frac{ac}{b}$; $\frac{a}{b}\div c=\frac{a}{bc}$; when a, b, c stand for any numbers.

Simplify $\frac{a-b}{ab}-\frac{a-c}{ac}+\frac{b-c}{bc}$

(1) $\frac{a}{b}\times c=\frac{ac}{b}$. For in each of the fractions $\frac{a}{b}$ and $\frac{ac}{b}$ the unit is divided into b parts, and c times as many parts are taken in $\frac{ac}{b}$ as in $\frac{a}{b}$, $\therefore$ $\frac{ac}{b}=c$ times $\frac{a}{b}$

(2) $\frac{a}{b}\div c=\frac{a}{bc}$. For in each of the fractions $\frac{a}{b}$, $\frac{a}{bc}$ the same number of parts (a) is taken, but each part in $\frac{a}{b}$ is c times as large as in $\frac{a}{bc}$, because in $\frac{a}{bc}$ the unit is divided into c times as many parts as in $\frac{a}{b}$ $\therefore$ $\frac{a}{b}\div c=\frac{a}{bc}$

Simplify $\frac{a-b}{ab}-\frac{a-c}{ac}+\frac{b-c}{bc}$

L.C.M. $=abc$.

$$=\frac{(a-b)c-(a-c)b+(b-c)a}{abc}$$

$$=\frac{ac-bc-ab+bc+ab-ac}{abc}$$

$$=\underline{0}. \text{ Ans.}$$

3. Solve the equations :—

(1) $\frac{1}{4}\left(4+\frac{3x}{2}\right)-\frac{1}{7}(2x-\frac{1}{2})=\frac{9}{14}$.

(2) $\frac{4x}{5-x}-\frac{20-4x}{x}=\frac{15}{x}$

(1) $\frac{1}{4}\left(4+\frac{3x}{2}\right)-\frac{1}{7}(2x-\frac{1}{2})=\frac{9}{14}$

$$1+\frac{3x}{8}-\frac{2x}{7}+\frac{1}{28}=\frac{9}{14}$$

$$168+63x-48x+8=186$$

$$15x=10$$

$$x=\underline{\frac{2}{3}}. \text{ Ans.}$$

(2) $\frac{4x}{5-x} - \frac{20-4x}{x} = \frac{15}{x}$

L. C. M. $= (5-x)x$.

$4x^2 - 100 + 40x - 4x^2 = 75 - 15x$

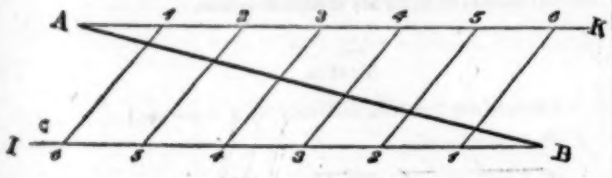
$55x = 175$

$x = \underline{3}$. Ans.

Mensuration.

(Answer *one* Question.)

1. To divide a given straight line into 7 equal parts.



Let AB be the given line.

Draw AK at any ∠ with AB. Through B draw BI parallel to AK.

Mark off on AK any length, A1, and repeat it five times, thus, A1, A2, A3, A4, A5, A6.

From B mark off the same distances, B1, B2, B3, B4, B5, B6.

Join A1 B6, A2 B5, etc., cutting AB in C, D, E, F, G, H. AB is divided into seven equal parts at those points.

2. Find the expense of carpeting a room, 18 ft. 9 in. long and 17 ft. 6 in. broad, with carpet 28 inches wide at 5s. 2d. per yard.

No. of yards of carpet required

$$= \frac{18\frac{3}{4} \times 17\frac{1}{2}}{2\frac{1}{3} \times 3}$$

$$= \frac{75}{4} \times \frac{35}{2} \times \frac{3}{7} \times \frac{1}{3}$$

$$= \frac{875}{8} \text{ yds.}$$

s.

Cost $= \frac{875}{8} \times 5\frac{1}{6}$

$= \underline{£12\ 2s.\ 2\frac{1}{2}d.}$ Ans.

Arithmetic.

FEMALES.

1. If $\frac{2}{15}$ of $1\frac{1}{2}$ of an estate be worth £300, what will be the value of the estate?

$\frac{2}{15}$ of $1\frac{1}{2} = \frac{2}{15} \times \frac{3}{2} = \frac{1}{5}$

$\frac{2}{15} = \frac{1}{5} \times 1\frac{4}{5} = 7$

£ £

$\frac{1}{5} : 7 :: 300 : \underline{4,200}$. Ans.

2. A traveller walked 120 miles in 6 days; in each of the first five days he walked an equal distance, in the sixth he walked 17·495 miles; required the number of miles he walked in each of the first *five* days.

		miles.
In 6 days he walked		120
On the sixth	,,	17·495
In the first five	,,	102·505
∴ On each of	,,	20·501 miles. Ans.

3. Divide £471·3756 into 4·74 equal parts, and give your answer in £ s. d. (Work to 4 places of decimals only.)

£

4·74)471·375600(99·4463

4266 — 20

4477 — 8·9260

4266 — 12

2115 — 11·1120

1896

2196

1896

3000

2844

1560

1422

138

£99 8s. 11·112d. Ans.

4. Reduce $\frac{3}{8}$ of a lb. $+ \frac{7}{10}$ of a qr. $+ \frac{3}{4}$ of a cwt. to the decimal of a ton.

$$\frac{\frac{3}{8} \text{ lb.} + \frac{7}{10} \text{ qr.} + \frac{3}{4} \text{ cwt.}}{1 \text{ ton.}}$$

$$= \frac{\frac{3}{8} + \frac{7}{10} \times \frac{28}{1} + 84}{2240}$$

$$= \frac{\frac{3}{8} + \frac{98}{5} + 84}{2240}$$

$$= \frac{103\frac{25+18}{30}}{2240}$$

$$= \frac{104\frac{13}{30}}{2240}$$

$$= \frac{3133}{67200}$$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following, parsing the words in italics:

O how *it yearned my heart*, when I *beheld*,
In London streets *that coronation day*,
When Bolingbroke rode on roan Barbary!
That horse, *that* thou so often hast *bestrid*,
That horse, that I so carefully have dressed!

RICHARD II.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*)						
O how it yearned my heart,	Prin. S.		It	yearned	my heart	O how (manner)
(*b*)						
when I beheld that horse in London streets that coronation day	Adv. S. (time) to (*a*)	when	I	beheld	that horse	in London streets (place) that coronation day (time)
(*c*)						
when Bolingbroke rode on roan Barbary	Adj. S. to (*b*)	when	Bolingbroke	rode	on roan Barbary (ind.)	
(*d*)						
that thou so often hast bestrid	Adj. S. to (*b*)	In rel.	thou	hast bestrid	that	so often (time)
(*e*)						
that I so carefully have dressed.	Adj. S. to (*b*)	In rel.	I	have dressed	that	so carefully (manner)

It—pers. pro., neut., sing., 3rd, nom. to *yearned*.
yearned—reg. trans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *it*.
my—pers. pro., masc., sing., 1st, poss., gov. by *heart*.
heart—com. noun, neut., sing., 3rd, obj., gov. by *yearned*.
beheld—irreg. trans. verb, act., ind., past, 1st, sing., agreeing with *I*.
that—adj. of distinction, sing. number, qualifying *day*.
coronation—com. noun, used as adj. of qual., qualifying *day*.
day—abs. noun, neut., sing., 3rd, obj., gov. by *on* understood.
that—adj. of distinction, sing. number, qualifying *horse*.
that—rel. pro., masc., sing., 3rd, agreeing with its antecedent *horse*, and gov. by *hast bestrid*.
bestrid—past part. of the verb *to bestride*, forming with *hast* the perf., ind., 3rd, sing. of *to bestride*.

2. What are impersonal verbs? Give examples.

Impersonal verbs are those which are used only in the third person singular with *it* as their nominative. Examples:—It thunders; it rains; it hails; it snows.

3. What is the origin and force of the particle 'be' in 'beheld,' 'bestrid'? Give instances of it as a prefix to *nouns*.

Be is an old English prefix meaning *by*. It is used to make transitive verbs from intransitive; to intensify the meaning of words; to make transitive verbs from adjectives or nouns; and with nouns. Examples:—Behalf, behoof, bequest, behest.

4. Most monosyllabic words are of *English* origin. Point out any exception to this rule in the above.

The word *street*, a monosyllable, comes from the Latin word *strata*.

Geography.

(*Answer two Questions.*)

1. Draw a map of the east coast of Asia, with the adjacent islands.

2. How is the circulation of the waters of the ocean carried on?

Water is expanded and made lighter by heat; it is also contracted and made heavier by cold. The intense heat at the equator and the great cold at the poles thus destroy the balance of pressure on the water; the heavy polar waters sink and flow under the lighter waters of the equator, and the lighter waters of the equator flow over towards the poles. Currents of different strength and dimensions are caused in different parts of the ocean by changes of temperature, and in many cases these currents are assisted by the winds, in many instances blowing steadily in one direction for weeks or months.

3. Give the position and description of any places in Africa we have been hearing about lately.

The places which have been talked of most frequently during the past year are Khartoum, Berber, Dongola, and Suakim.

Khartoum is at the junction of the Blue and White Nile Rivers. It is the modern capital of Nubia, contains from 15,000 to 20,000 inhabitants. It is the centre of the trade of the Eastern Soudan, is at present fortified against the Mahdi by General Gordon.

Berber is about 200 miles N. of Khartoum, a little south of the fifth cataract of the Nile, and near the junction of the Atbara with that river.

Dongola is between the third and fourth cataracts of the Nile, and is as large as Khartoum. Its situation is of importance as a military and commercial depôt.

Suakim is on the Red Sea coast of Nubia, on the same parallel as Berber, from which it is distant about 200 miles.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. Find the true discount on £8175 7s. 6d., due 146 days hence, interest being at 3½ per cent. per annum.

Int. on £100 = $\frac{7}{2}\frac{1}{0}\frac{4}{0}\frac{6}{0} \times \frac{7}{2} = £\frac{7}{2}$
£ £ £ £
∴ 100½ : 8175½ :: $\frac{7}{2}$: x
$= £\underline{129}$. Ans.

2. Find the square root of ·4, and of ·001593606 to 4 decimal places.

$\sqrt{\cdot 4} = \sqrt{\frac{4}{10}} = \frac{2}{3} = \cdot\underline{6}$. Ans.

·001593606(·0399. Ans.
9
69) 693
621
789) 7260
7101
159

3. A man invested £5850 in 3 per cents. at 97½, and when the stocks rose to 99¼ he sold out; what did he gain, a brokerage of ¼ per cent. being charged on each transaction?

He bought 58½ cents. at 97½ + ¼ or 97¾
He sold 58½ cents. at 99¼ − ¼ or 99½
On every cent. he gained 99½ − 97¾ = 2½
∴ Total gain = 2½ × 58½
$= £\underline{146}$ 5s. Ans.

4. Two pieces of lead ore weighed 12 and 18 lbs. (avoirdupois) respectively, and the two contained 1½ lbs. of silver. If the bigger contained 6 per cent. of silver, what per cent. of silver did the smaller contain?

Amount of silver in bigger piece
= $\frac{6}{1}\frac{0}{0}$ of 18 = $\frac{3}{5}$ = $1\frac{3}{5}$ av. lbs.
$1\frac{3}{5}$ lbs. av. = $\frac{3}{5} \times \frac{1}{1}\frac{4}{2}\frac{4}{0} = 1\frac{1}{5}$ lbs. Troy.
Amount of silver in smaller piece
= $1\frac{1}{2} - 1\frac{1}{5} = \frac{3}{10}$ lbs. Troy.
$\frac{3}{10}$ lbs. Troy = $\frac{3}{10} \times \frac{1}{7}\frac{4}{6}\frac{4}{0} = \frac{3}{7}\frac{7}{5}$ lbs. av.
∴ Percentage of silver in smaller piece =
12 : 100 :: $\frac{3}{7}\frac{7}{5}$: x
$= 1\frac{1}{2}$. Ans.

History.

MALES AND FEMALES.

1. When did the Civil War break out in the reign of Charles I.? Name some of the principal characters and tell the side each espoused.

When Charles set up his standard at Nottingham, on the 22nd of August, 1642. Among the most important characters who were engaged in the war were:—Prince Rupert, Lord Falkland, Earl of Lindsay, Duke of Newcastle, Earl of Montrose, Duke of Hamilton, Prince Charles, and Duke of York, on the side of the king; and Oliver Cromwell, Henry Ireton, Earl of Essex, Sir Thomas Fairfax, John Hampden, Earl of Manchester, Sir William Waller, on the side of the Parliament.

2. What can you tell of the foreign policy of England under Walpole, Chatham, and Pitt?

The policy of Sir Robert Walpole was to keep at peace if possible. He was driven into war with Spain by the embittered feeling of the people against that country, because of the manner in which they tried to check trade with their American colonies. The war was not very successful and Walpole retired from office.

The Earl of Chatham began his political career by joining the 'Patriots' in the House of Commons, and his policy was to make England feared. He could not bear that she should be humiliated, and throughout his career he went to war whenever there was an opportunity. His last speech was in opposition to the surrender of the colonies aided by France.

William Pitt, second son of the Earl of Chatham, was desirous of maintaining peace, but not at the expense of the honour of the country. He prosecuted, therefore, the war with France with vigour, and the success of Napoleon against Austria was to him such a blow as to materially hasten his death.

3. A queen died of small-pox at Kensington Palace about 190 years ago; who was she? Explain the satire in the following lines of that period:—

'There's Mary, the daughter; there's Billy, the cheater;
There's Geordie, the drinker; there's Annie, the eater.'

Mary II., wife of William III.

The lines have reference to Mary, daughter of James II., William III. her husband, George, Prince of Denmark, and his wife Queen Anne. They have reference to the characters of the individuals. Charles II. said of George, 'I have tried him drunk and sober, and there is nothing in him.' Anne was fond of the pleasures of the table. The reference to Mary is in reproof of her ascending the throne of her father, and to William for being the means of the deposition of James II.

Teaching.

Write the notes of a lesson on the Electric Telegraph.

Introduce the lesson by speaking of the means of transmitting messages from place to place, and reference to telegraph wires seen by all scholars. Then give names, magnetic and electric, with their definitions and meanings. Sketch very briefly the history of electricity, and show that the electric telegraph requires three things, the battery, a line, and an indicator.

1. *The Battery.*—For the purpose of producing the power, may be frictional or chemical. Latter chiefly used; a series of copper plates and zinc, arranged in wooden troughs, divided into compartments, and coated with shellac. After introduction of

plates, the cells are filled with sand, and moistened with dilute sulphuric acid. Sketch the battery and plates on blackboard.

2. *The Line.*—Made of galvanized iron wire, suspended on posts, from which the wire is insulated (explain, and why?) by glass or porcelain tubes. Must stretch from place to place between which messages are to be sent.

3. *The Indicator.*—Sketch the multiplier, and show how the needle at the front of the machine is deflected, and that the like instrument at the opposite end of the wire is deflected similarly; letters placed on either side are indicated by different deflections of the needle. Name other instruments and methods of despatching and receiving messages.

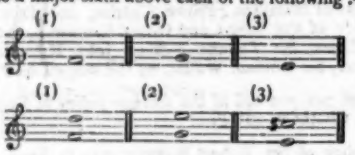
4. *Uses and Benefits.*—To commerce and every condition of life, newspapers, foreign countries.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write a major sixth above each of the following:—



1. (1) (2) (3)

2. Re-write the following, doubling the value of every note and rest:—

2.

3. State (briefly) the meanings of the following terms:—(1) *Da Capo*; (2) *pianissimo*; (3) *dolce*.

3. (1) From the beginning; (2) very soft; (3) sweetly.

TONIC SOL-FA NOTATION.

1. Write major sixths above the following:—(1) *doh*; (2) *ray*; (3) *soh*.

1. (1) *lah*; (2) *te*; (3) *me*.

2. What are the five kinds of measure commonly used?

2. Two-pulse; three-pulse; four-pulse; six-pulse; nine-pulse.

3. Explain the following terms:—(1) *Da Capo*; (2) *pianissimo* (3) *dolce*.

3. (1) From the beginning; (2) very soft; (3) sweetly.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Two hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 1, if you can.

1. To describe a parallelogram that shal be equal to a given triangle, and have one of its angles equal to a given rectilineal angle.

Euclid, Book I., Prop. 44.

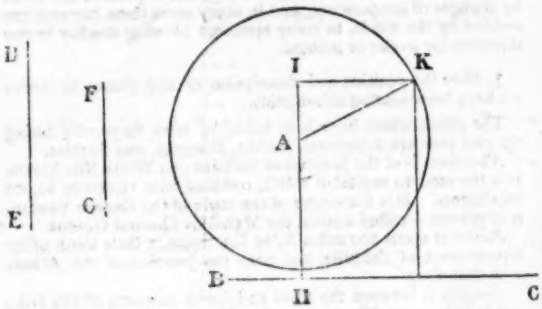
2. If a straight line be divided into any two parts, the squares on the whole line, and on one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the square on the other.

Euclid, Book II., Prop. 7.

3. To find a point at a given distance from a given point, and also at a given distance from a given line.

Show that under certain conditions the problem is impossible.

Let A be the given point, and BC the given straight line. It is required to find a point which shall be at the given distance DE from A, and at the given distance FG from the line BC.



From A let fall a perpendicular AH to BC. On HA, or HA produced, cut off HI=FG. From A with radius AK=DE describe circle K. Through I draw IK parallel to BC, meeting circumference in K.

Draw KL parallel to HI. K is the point required.

KL is parallel to HI, and IK to HL.

∴ KL=HI, and HI=DE. ∴ KL=DE, and AK=FG.

∴ Point K is distant DE from A, and FG from BC.

No point can be found when the combined distances between the point and the given point, and the point and the given line, are less than the distance from the given point to the given line.

Algebra.

Answer two Questions, including No. 2, if you can.

1. Divide $\frac{a^2}{bc}-\frac{2a}{d}+\frac{ac}{be}-\frac{c^2}{de}+\frac{bc}{d^2}$ by $\frac{a}{b}-\frac{c}{d}$

$$\frac{a}{b}-\frac{c}{d}\Big)\frac{a^2}{bc}-\frac{2a}{d}+\frac{ac}{be}-\frac{c^2}{de}+\frac{bc}{d^2}\Big(\frac{a}{c}+\frac{c}{e}-\frac{b}{d}$$

$$\frac{\frac{a^2}{bc}-\frac{a}{d}}{\frac{ac}{be}-\frac{c^2}{de}}$$

$$\frac{\frac{ac}{be}-\frac{c^2}{de}}{-\frac{a}{d}+\frac{bc}{d^2}}$$

$$-\frac{a}{d}+\frac{bc}{d^2}$$

2. State and explain the rule for finding the cube root of an algebraical expression.

Find the cube root of $8a^6x^6-84a^4x^4by^3+294a^3x^2b^2y^6-343b^3y^9$.

Arrange the terms according to the powers of one of the letters, the highest power first; extract the cube root of this term first; subtract; then divide the first term of the remainder by three times the first term of the root squared for the second term of the root; subtract the cube of the sum of the terms thus found, and continue the process till all the terms of the root are found.

For convenience the work can be arranged in three columns as in the following example.

$$
\begin{array}{l|l|l}
8a^6x^6 - 84a^4x^4by^3 + 294a^2x^2b^2y^6 - 343b^3y^9 & & (2a^2x^2 - 7by^3 \\
8a^6x^6 & & \\
\hline
 & -84a^4x^4by^3 + 294a^2x^2b^2y^6 - 343b^3y^9 & \\
 & -84a^4x^4by^3 + 294a^2x^2b^2y^6 - 343b^3y^9. & \\
\hline
 & & 6a^4x^4 - 7by^3 \\
 & 12a^4x^4 & \\
 & +(6a^4x^4 - 7by^3)7by^3 & \\
\hline
 & 12a^4x^4 + 42a^2x^2by^3 - 49b^2y^6 & \\
\end{array}
$$

3. Solve the equations :—

$$1.\ \begin{cases} 45x + 8y = 350 \\ 21y - 13x = 132 \end{cases}$$

$$2.\ \frac{x+1}{x-1} - \frac{x-1}{x+1} = 1.$$

In the last, find the roots correct to 2 places of decimals.

$$1.\ 45x + 8y = 350 \quad (1)$$
$$21y - 13x = 132 \quad (2)$$

Mult. (1) by 21 and (2) by 8, and subtract

$$945x + 168y = 7350$$
$$-104x + 168y = 1056$$
$$1049x = 6294$$
$$x = 6. \text{ Ans.}$$

Substituting value of x in 2.

$$21y - 78 = 132$$
$$21y = 210$$
$$y = 10. \text{ Ans.}$$

$$2.\ \frac{x+1}{x-1} - \frac{x-1}{x+1} = 1$$
$$(x+1)^2 - (x-1)^2 = (x-1)(x+1)$$
$$(x^2 + 2x + 1) - (x^2 - 2x + 1) = x^2 - 1$$
$$4x = x^2 - 1$$
$$x^2 - 4x = 1$$
$$x^2 - 4x + (2)^2 = 1 + (2)^2$$
$$x - 2 = \pm\sqrt{5}$$
$$x = \pm\sqrt{5} + 2$$
$$= \pm 2{\cdot}23 + 2$$
$$= +4{\cdot}23 ; -{\cdot}23. \text{ Ans.}$$

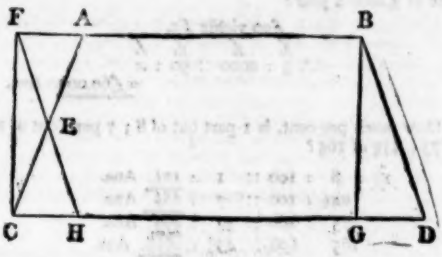
Mensuration.

Answer one Question.

1. State and prove the rule for finding the area of a trapezoid.

Multiply half the sum of the two parallel sides by the perpendicular distance between them, and the product will give the area.

Let ABCD be a trapezoid, of which AB,CD are the parallel sides. The area of ABCD = ½ AB and CD × perpendicular distance BG between them.



Bisect AC in E. Through E draw HF parallel to BD to meet BA produced to F. Draw FC perpendicular to BG.

Then FD is a parallelogram (I. 34), and FB = HD. ∴ FB = half FB,HD.

But AB,CD = FB,HD, for AF = CH (I. 26.)

∴ FB = half AB,CD.

And FD = FG (I. 35). And FG is a rectangle, and its area is found by mult. FB by BG.

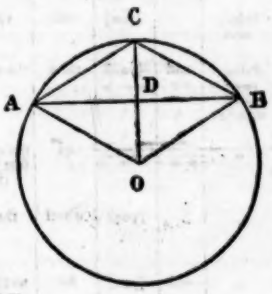
∴ Area of FG = FB × BG.

But ABCD = FG. ∴ Area of ABCD = FB × BG.

But FB = half sum of AB,CD, and BG = perpendicular between them. Wherefore, the area, etc.

2. The radius of a circle is 10 feet; the angle of a sector of it is 120°; find the area of the segment.

AOB = 120°. ∴ AOC = 60°, and AC = AO = 10. ∴ CD, DO are equal, and each = 5.



Area of sector = 360 : 120 :: (·7854 × 20²) = 104·72.

AB = $\sqrt{(10^2 - 5^2)}2 = 17{\cdot}32$.

∴ Area of triangle ABO = 17·32 × ½ = 43·3.

∴ Area of segment ACB = 104·72 − 43·3

= 61·42 feet. Ans.

Arithmetic.

FEMALES.

1. Find the smallest sum of money that can be divided exactly into shares of £23 16s. 8d. and £31 3s. 4d. each.

£23 16s. 8d.; £31 3s. 4d;

or 23⅓, 31⅓.

L.C.M. = $1\frac{1}{3}^3 \times 1\frac{1}{3}^7$

= £405 3s. 4d. Ans.

2. A wall 1,690 feet long has to be built in 30 days, and it is found that 7 men in 14 days have completed only 490 feet; how many additional men must be employed that the wall may be finished in the required time?

Men to do 490 in 14 days = 7

" " 1 " 1 day = $\frac{7 \times 14}{490}$

" " 1200 " 16 days = $\frac{7 \times 14 \times 1200}{490 \times 16}$

= 15 men

No. to be add'd = 15 − 7 = 8 men. Ans.

3. How much money must one invest in the 3 per cent. Consols, when they are at 10 per cent. below *par*, in order to have an income of £2000 a year?

£90 yields £3.

£ £ £ £

∴ 3 : 2000 :: 90 : *x*

= £60,000. Ans.

4. How much per cent. is 1 part out of 8; 7 parts out of 24½; 37 of 75; 43¾ of 165?

8 : 100 :: 1 : 12½. Ans.

24½ : 100 :: 7 . 28⅔. Ans.

75 : 100 :: 37 : 49⅓. Ans.

165 100 :: 43¾ : 26⅔. Ans.

Grammar.

MALES AND FEMALES.

1. Now stir the fire, and *close* the shutters *fast*,
Let *fall* the curtains, *wheel* the sofa *round*,
And while the bubbling and *loud*-hissing urn
Throws *up* a steamy *column*, and the cups
That cheer but not inebriate, *wait* on *each*,
So let us *welcome* peaceful evening *in*.

Analyse the above passage, and parse the words in italics.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extensn.
(*a*) Now stir the fire	Princ. sent.		[you]	stir	the fire	now (time)
(*b*) and close the shutters fast	Princ. sent. co-ord. with (*a*)	and	[you]	close	the shutters	fast (manner)
(*c*) let fall the curtains	,,		[you]	let	the curtains (dir.) to fall (ind.)	
(*d*) wheel the sofa round	,,		[you]	wheel	the sofa	round (manner)
(*e*) and so let us welcome peaceful evening in	,,	and	[you]	let	us (dir.) to welcome peaceful evening in so (ind.)	
(*f*) while the bubbling and loud-hissing urn throws up a steamy column	Adv. sent. (*time*) to (*e*)	while	the bubbling and loud hissing urn	throws	a steamy column	up (place)
(*g*) and the cups wait on each	,,	and	the cups	wait	on each (ind.)	
(*h*) that cheer	Adj. sent. to (*g*)	In rel.	that	cheer		
(*i*) but not inebriate	Adj. to (*g*)	but	[that]	inebriate		not (neg.)

Close—reg. trans. verb, act., imp., 2nd, plur., agreeing with its nom. *you* understood.
fast—adv. of manner, qualg. *close*.
fall—verb, irreg. intrans., act., inf., pres., gov. by *let*.
wheel—reg. trans. verb, act., imp., 2nd, agreeing with its nom. *you* understood.
round—adv. of manner, qualg. *wheel*.
loud—adj., used as adv. of manner, qualg. *hissing*.
up—adv. of manner, qualg. *throws*.
column—com. noun, neut., sing., obj. case, gov. by *throws*.
that—rel. pro., neut., plur., 3rd, nom. to *cheer*.
cheer—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *that*.
but—disj. conj., joining the sents. 'That cheer' and 'That inebriate not.'
not—adv. of negation, qualg. *inebriate*.
inebriate—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *that* und.
wait—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *cups*.
each—distrib. adj., qualg. *person* understood
so—adv. of manner, qualg. *welcome*.
welcome—reg. trans. verb, act., inf., pres., gov. by *let*.
in—adv. of manner, qualg. *welcome*.

2. From what source is the word 'sofa' derived? Mention other words derived from the same source.

Arabic. Other words:—Alcohol, algebra, bazaar, caravan, divan, emir, fakir, giraffe, harem, jar, magazine, nadir, opium, syrup, tariff, vizier, zenith.

3. To what dates and events would you assign the adoption and discontinuance of French as the language of the Court and nobility in England?

The Normans brought French into England at the invasion in 1066, and it was used by the Court and nobility till the end of the fourteenth century. The loss of our French possessions in John's reign weakened the hold of the nobility on the French language. The strong anti-French feeling engendered in Edward III.'s reign, is given as the cause of its ultimate rejection for English.

4. Name the authors of the following works:—'Paradise Lost,' 'The Faery Queen,' 'Vanity Fair,' 'Robinson Crusoe,' 'The Task,' 'Kenilworth,' 'The Excursion,' 'The Idylls of the King.'

'Paradise Lost' ... John Milton
'The Faery Queen' ... Edmund Spenser
'Vanity Fair' ... William Makepeace Thackeray
'Robinson Crusoe' ... Daniel Defoe
'The Task' ... ... William Cowper
'Kenilworth' ... ... Sir Walter Scott
'The Excursion' ... William Wordsworth
'The Idyll's of the King' Alfred, Lord Tennyson

Geography.

(*Answer two Questions.*)

1. Draw a map of the West Indies.

What European nations have possessions there?
Name the colonies belonging to them.
English, French, Dutch, Spanish.

English.—Jamaica, Bahamas, Leeward Is. (Virgin Is., Barbuda, St. Kitts, Nevis, Antigua, Montserrat, Dominica), Windward Is. (St. Lucia, St. Vincent, Barbadoes, Grenada, Tobago), Trinidad.
Spanish.—Cuba, Porto Rico, part of Hayti.
French.—Guadaloupe, Martinique.
Dutch.—Small islands off Venezuela.

2. How would you make a class understand about the seasons?

Use the globe with axis inclined 23½ degrees, and also one with light or a candle to represent the sun. Move the earth, keeping its axis always parallel to itself, round the representation of the sun. Let the earth revolve at the same time that it is moved in its orbit. Draw attention to it first in its position in summer and winter, and the children readily perceive that round about the North Pole great heat and light will be received, while the South Pole is entirely beyond the reach of light or heat from the sun, and *vice versâ*. Move the globe slowly from each of these positions, and show that the amount of heat and light received becomes less or greater as the earth moves from one position to the other. When mid-way between the two draw attention to the fact that both poles receive an equal amount of heat. The use of the globe in this way enables children readily to understand long and short, and equal days and nights, and the variations of the seasons.

3. Give any interesting particulars about the inhabitants or productions of the Torrid Zone.

The inhabitants of the Torrid Zone belong to the darker varieties of the human race, and are generally lower in the scale

of civilization than those of the Temperate Zone. The Torrid Zone is inhabited by the Negro in Africa, and the Malay and Mongolian in Asia. The fruitfulness of the soil and the intense heat prevent the development of the physical and mental powers of the people. The vegetable productions of the Torrid Zone are of a most luxuriant character. The trees are of immense growth, the fruits generally of a luscious character, and the grasses, shrubs, and smaller plants plentiful and varied. Of the trees may be mentioned the banyan, banana, bread-fruit, and palms of various kinds, as well as all the varieties of fancy woods, indiarubber, gutta percha, and other gum trees. The animal productions include all the fierce varieties of wild animals, and the poisonous and venomous snakes; the fish also are of the voracious kind.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. A woman by selling eggs at 5 for 3d. gained 8 per cent.; what per cent. would she have gained if she sold them at 12 for 7d.?

First price of one egg $= \frac{3}{5}$d.
Sec. " " " $= \frac{7}{12}$d.
$\therefore$ Selling price $= \frac{3}{5} : \frac{7}{12} :: 108 : x = 105$
And gain $= 105 - 100 =$ 5 per cent. Ans.

2. A invested a certain sum in $4\frac{1}{2}$ per cent. stocks at 125, and B lent an equal sum at $3\frac{1}{2}$ per cent. interest; at the end of 12 months A received £5 4s. more dividend than B. What sum did each invest? (Omit brokerage.)

A received as interest
As 125 : 100 :: $4\frac{1}{2} : x = 3\frac{1}{2}$ per cent.
For every £100 he lends, therefore, he gets
$£3\frac{1}{2} - 3\frac{1}{2} = £\frac{1}{125}$ more than B.
No. of £100's $= \frac{£5\ 4s.}{£\frac{1}{125}} = 52.$
$\therefore$ Amount lent $=$ £5200. Ans.

3. A and B join in partnership; A puts in the business £300 and B £500; at the end of six months A puts in £400 more and B takes out £100. How should a gain of £61 15s. be divided amongst them at the end of 12 months?

£
A's proportion of capital $=$
$(300 \times 6) + (700 \times 6) = 6000$
B's proportion $=$
$(500 \times 6)\ (400 \times 6) = 5400$
Total capital $= 11400$
A's share of profit $= \frac{6000}{11400} \times 3\frac{1}{4}^{L} =$ £32 10s. Ans.
B's " " $= \frac{5400}{11400} \times 3\frac{1}{4}^{L} =$ £29 5s Ans.

4. If the circumferences of the two wheels of a bicycle are 48 and 196 inches, after how many turns of each will two points in the circumferences come back into the same relative position?

The larger wheel makes 1 revolution while the smaller makes $\frac{196}{48} = 4\frac{1}{12}$.
The No. of turnings of each before they occupy the same relative position therefore will be
As $1 : 4\frac{1}{12}$
Or 12 : 49. Ans.

History.

MALES AND FEMALES.

1. Compare the power of Parliament under Henry VII., Queen Elizabeth, and William III.

Under Henry VII. the power of Parliament was restricted rather than extended. The nobility had been nearly destroyed during the Wars of the Roses, and Henry was imperious and avaricious. His reign was the commencement of a season of almost despotic rule. Justice was wrested for the purpose of extorting money, and punishments were rigorously enforced, the authority of the Star Chamber being paramount.

Parliament had apparently little more power under Elizabeth than under Henry VII.; but gradually its influence and desires were beginning to be more felt and consulted. Elizabeth, however, yielded gracefully to some of the demands made upon her, and the growing power of Parliament was manifested in the succeeding reign.

Under William III. the power of the Parliament became supreme. Upon the Parliament he depended for his crown. The Bill of Rights provided that the levying of taxes or keeping a standing army without its consent was illegal. Imposition of excessive fines, unnecessary punishments, and the dispensing with laws, were condemned; while the Mutiny Act necessitated Parliament being called together every year.

2. Which was our last possession in France? Give an account of its loss.

Calais was the last of the French possessions held by England. It was lost in the reign of Mary, 1558.

Philip, her husband, who was king of the Netherlands, as well as of Spain, prevailed upon Mary to assist him in a war against France. Calais had been neglected and was left only partially defended. The allies were successful at St. Quentin, in 1557 (August 10th), but the Duke of Guise successfully attacked Calais, and took it on January 7th of the following year. The loss was a great blow to English pride, and it served to break the queen's heart.

3. What are the principal branches of manufacture in the United Kingdom? Describe their rise and progress.

The principal manufactures in the United Kingdom are cotton, woollen, iron, linen, and silk goods.

Cotton was early introduced into this country; but its development as a manufacture began with the invention of the spinning jenny, in 1784, by Hargreaves. Arkwright next invented the water frame, to spin by rollers, and Crompton the mule. With the invention of the power-loom the increase of production was very rapid, till now some 1,200 millions of lbs. of cotton are used annually.

Woollen goods were first manufactured in England in quantities by the Flemings, who settled here in the reign of William I. Each successive king encouraged the manufacture. In Edward III.'s reign it increased rapidly. On the revocation of the Edict of Nantes, 50,000 Huguenots settled here, and the manufacture has since been one of progress. Localities suitable to the trade were selected on account of their facilities for obtaining the raw material. We now import 150 million lbs. of wool yearly, in addition to our own growth.

Linen was not a common manufacture till the invention of the machines above named. The soil of England is not suitable for the growth of flax, which is nearly all procured from the Continent. England imports yearly 150,000,000 lbs. of raw material.

Iron was formerly smelted in the eastern counties; now on all the coal-fields. Great progress has been made during the last century.

Silk-weaving was introduced by the Huguenots, and it is principally to them we owe our manufactures at Coventry, Manchester, and London.

4. 'Peter was first elected Tsar in the spring of 1682, when the Whigs were conspiring against Charles II., three years before the Revocation of the Edict of Nantes, and a year after Strasburg and Alsace had been annexed by Louis XIV., the same year that William Penn was colonising Pennsylvania and La Salle exploring Louisiana.' Give some account of any *two* of the historical events alluded to.

In 1681 a scheme was formed to exclude James from the throne. Monmouth, Russell, Sidney, and other Whigs, concerted measures along with the Scots for risings in several places. Unknown to them the Rye House Plot was also set on foot. It was discovered, and the leaders of the first plot were accused of participation, and several of them (Russell, Sidney, etc.) were beheaded.

The Revocation of the Edict of Nantes was the work of Louis XIV. In 1598 Henry IV. had established by the Edict liberty of worship in France. When it was revoked the lives of Protestants were endangered, and many of them left France and settled in Holland, Belgium, Germany, and England, to the great advantage of the manufacturing industries of all those countries

Teaching.

Write out notes of a lesson on the 'MANUFACTURE OF PAPER.'

1. *Substances used in Manufacture.*

Introduce lesson by noting necessity of communication with absent friends, etc., and early methods of same—writing on *wax tablets*, *bark of trees* (rendered as smooth as possible, *papyrus* (leaves laid side by side and made to adhere), *skins of animals* (soaked in lime-water, cleaned, and smoothed). Present substances—rags, chips, sawdust, straw, grass, cabbage-stalks, almost anything vegetable.

2. *Preparation of Materials and Manufacture.*

Rags procured from every part of the country and world by ragmen (seen by all), sorted, white removed from coloured, cleansed from buttons, hooks and eyes, and other foreign substances; thoroughly washed, placed in cylindrical machine (drum), in which spikes are placed, revolution of machine tears rags to pieces, reduced to pulp. Pulp run on to wire frame, deposited in layers, dried over steam rollers and by fan, wound on to rollers. (Sketch machines on blackboard, or show picture.) Writing-paper glazed, passed through a kind of glue called size; different colours given to it by placing colouring matter in pulp.

3. *Varieties of Paper.*

(*a*) Note paper, made of best white rags, sized well and passed over heated plates. Rolls cut into large sheets by guillotine (sketch), made up into quires of 24 sheets.

(*b*) Brown paper, made of straw, canvas, and other coarse materials.

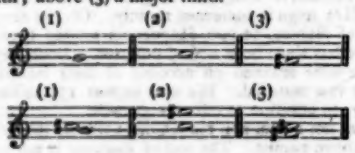
(*c*) Pasteboard and cardboard, several layers of paper glued, fine paper pasted on outside.

Music.

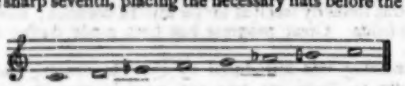
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third.



2. Write the ascending scale of C minor, using the minor sixth and the sharp seventh, placing the necessary flats before the notes.



3. Complete each of the following bars by adding the necessary rest or rests :—

TONIC SOL-FA NOTATION.

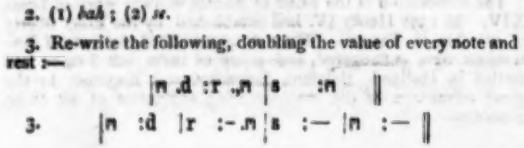
1. Write above (1) *soh* an augmented second; above (2) *ray* an augmented fifth; above (3) *me* a major third.

1. (1) *le*; (2) *le*; (3) *se*.

2. In the minor mode (1) what is the essential sixth; and (2) what is the essential seventh?

2. (1) *lah*; (2) *se*.

3. Re-write the following, doubling the value of every note and rest :—



Recent Inspection Questions.

[The Editor respectfully solicits contributions—all of which will be regarded as STRICTLY PRIVATE*—to this column. For obvious reasons, it cannot be stated in which district the questions have been set.]*

Arithmetic.

STANDARD I.—(DICTATED).

(1) 789 + 876 + 948 + 67 + 776. Ans. 3,456.
(2) 804 − 138. Ans. 666.
(3) 456 − 369. Ans. 87.

STANDARD II.—(DICTATED).

(1) 63,745 × 86. Ans. 5,482,070.
(2) 32,809 ÷ 7. Ans. 4,687.
(3) 46,310 − 19,708. Ans. 26,602.

STANDARD III.

(1) Divide 52,970,925 by 192.
Ans. 275,890 + 45.

(2) Add £29 15s. 11½d., £507 16s. 10d., £485 7s. 8½d., £2,690 12s. 3¾d., and £1841 12s. 7½d. Ans. £5,555 5s. 5d.

(3) (Given in words.)—Take £8,389 18s. 10½d. from £9,909 9s. 9d. Ans. £1,519 10s. 10½d.

(4) How many bags of 24 marbles each can be filled from a box which contains 4,800?
Ans. 200.

PROBLEMS.

Card G.—A cut down 340 trees out of 1,002; B cut down half the remainder; C cut down 330. How many were there left? Ans. 1.

Card E.—A man had 30,040 bricks; after selling 15 loads, each containing 550, how many has he yet to sell? Ans. 21,790.

Card H.—There are two vessels, one holds 3 galls., the other 1 gall.; and there is also a well holding a thousand galls. How many galls. are there left after filling each vessel out of the well 250 times?
Ans. None.

STANDARD IV.

(1) Multiply £755 12s. 9¼d. by ninety-two.
Ans. £69,518 14s. 11d.

(2) Divide £528,076 10s. 1¼d. by 527.
Ans. £1,002 0s. 10½d.

(3) How many persons can each receive 15s. 1d. out of a sum of £40 14s. 6d.? Ans. 54.

(4) In eleven million and twenty-two thousand ounces, how many tons, etc.? Prove your answer.
Ans. 307 tons 10 cwt. 2 qr. 19 lb.

STANDARD V.

(1) Find by practice the cost of 5,908 articles at 16s. 7½d. each. Ans. £4,911 0s. 6d.

(2) 7 cwt. 2 qrs. 19 lbs. 12 ozs. at 25s. 8d. a qr.
Ans. £39 8s. 1½d.

(3) If a farmer sells 500 sheep at the rate of 4 for £9, how much will he receive? Ans. £1,125.

(4) Make out the following bill—:
37 lbs of tea at 2s. 2¾d. per lb.
49 lbs. of coffee at 1s. 8¼d. a lb.
1½ cwt. of sugar at 5½d. a lb.
690 lbs. of rice at the rate of ¾d. for 20 ounces.
Ans. £13 16s. 8d.

Dictation.

STANDARD I.

All good boys and girls go to school every day.

STANDARD II.

For about one hour she stood thus, till her husband came with a hive. He soon picked out the queen-bee and put it in the hive; and in a short time the whole swarm entered it too, without having done the lady the least harm.

STANDARD III.

The king sat thinking about his poor countrymen, and how he might best deliver them from the Danes, and so he quite forgot all about the cakes. When the herdsman's wife returned to the hut, she found them all black and burnt. She was of course very angry, and told Alfred he was ready enough to eat the cakes but too idle to watch them.

STANDARD IV.

On August 28th, 1782, she was off Portsmouth, having just returned from a cruise. As she was riding quietly at anchor, surrounded by some two or three hundred ships of all kinds, it was discovered that a pipe, used to admit water for cleansing purposes, was out of repair. In order to examine this, it was found necessary that the ship should be heeled over, as the mouth of the pipe was three feet below the surface.

Grammar.

STANDARD II.

Pick out three nouns and three verbs from the piece of dictation.

STANDARD III.

Pick out three nouns, three verbs, three adjectives, three pronouns, and three adverbs from the piece of dictation.

STANDARD IV.

Parse:—

The land-breeze shook the shrouds,
And she was overset.

STANDARD V.

Parse and analyse:—
Thou art come to answer a strong adversary.

STANDARDS VI. AND VII.

(1) Parse and analyse:—
If you have tears, prepare to shed them now.
(2) Point out the word in the above complex sentence which has a Latin prefix, give the meaning of it, and write down other examples.

Composition.

STANDARD VII.

Write an essay on Spring.

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

It was not until the year 1840 that the name of Kinder-garten was applied to the new institutions. Fröbel had long been meditating on it. 'One day,' so Barop tells us, 'we—Fröbel, Middendorff, and myself—took a long walk over the *Steiger* to Blankenburg. Fröbel exclaimed repeatedly: "If I but knew a suitable name for my youngest child!" Blankenburg lay at our feet, and in deep meditation he went along. Suddenly he halted, and with beaming eyes, like one inspired, he shouted aloud into the mountains: "Ευρηκα! Kinder-garten shall the Institute be named!" and "Kinder-garten!" was echoed from the four quarters of the heavens!'

Shortly after the publication of the *Mutter and Koselieder*, there appeared—*Ein hundert Ball-lieder, zu den in dem Kinder-garten zu Blankenburg ausgeführten Spielen. Musik von R. Kohl.* ('One Hundred Songs to the Games at Ball, as played in the Kinder-garten at Blankenburg'); and also *Zweite Gabe* ('Second gift'); and, in 1844, *Anleitung zum Gebrauch der Dritten Gabe* ('How to use the Third Gift').

The propagation of the Kinder-garten by means of public lectures in every place of note in the south of Germany continued to be the foremost care of the united friends, very often under great personal privations, and all but overwhelming difficulties. Indeed, to us it must appear marvellous how they could have managed to accomplish so much with such scanty means. Fröbel's life from beginning to end was a constant struggle with difficulties and adverse powers, but he never gave way. Pestalozzi's word, written in his album, was always present in his mind, and to it he stuck; come what may, all other things must take their course, *he* must work, work, work incessantly—

'Der Mensch bahnt sich mit der flamme
Des Denkens und mit dem funken des Redens
Den Weg zu seinem Ziel.
Aber er vollbringt diesen Weg
Er vollendet sich selber
Nur durch Schweigen und Thun.'

'With the flame of thought,
With the spark of speech,
Man works his way
To his coveted aim,
But he (achieves his plan), completes this way,
He perfects himself
Only by silence and work.'

That in this way many friends should have been won among all classes of society is quite natural, but as natural, in a man like Fröbel, was the idea to unite what was scattered about here and there and everywhere. From his early life Fröbel's aspirations aimed at unity, and nobody that knew Fröbel at all could feel surprised at another innovation which he was now so eager to introduce, viz., educational societies. Deeply impressed with the necessity and the immense importance of such associations of thoughtful men, more especially of parents, he now devoted all his energy to their realisation. He suggested as their threefold aim: A better acquaintance with the general state of public and private, especially home education, its requirements, and its hindrances; secondly, a consideration of the means and ways of meeting those

requirements; and thirdly, the practical application of the results of such studies. He had the satisfaction to see the formation of several such societies.

It was a subject of sore trouble to him that he found himself compelled to relinquish his favourite work at Blankenburg. Under the fatal impression that such institutions had greater chance of success when worked in a grand style from the very outset, and perhaps confiding too much in the success of his financial operations, he had exceeded his powers. The expected succours failed, the plan had to be given up, and the Kinder-garten was transferred to Keilhau. The training of young women for the Kinder-garten now absorbed all his energy. Many excellent teachers, many exemplary mothers, whose names God's angels have inscribed in the Book of Life, point to Keilhau as the place where the germs of a new spiritual life were laid. One of them, the daughter of Professor Herrmann, in Dresden, who seemed born for the realisation of Fröbel's ideas, married Adolph Frankenberg; under her care the Dresden Kinder-garten soon numbered eighty pupils. Another, Fraulein Louise Levin, of Osterode, so long the residence of Christian, Fröbel's faithful brother, will afterwards claim our particular attention. Gradually the Kinder-garten idea had acquired a great reputation, not only in Thuringia, but throughout the whole of Germany, and Dr. Zeh's prophecy had been verified. The attacks of its adversaries had considerably augmented its fame. Fröbel, therefore, thought it expedient to invite the teachers, and all the friends of education, to a general meeting, in order to a thorough and exact investigation of his system. This meeting took place at Rudolstadt, in the autumn of the year 1848.

It was not, however, simply a meeting; it was a congress, a fiery ordeal through which the work of his life had to pass. Never had the indefatigable old warrior been exposed to such a series of attacks, most of which sprang from sheer ignorance, or merely superficial acquaintance with the subject. Fröbel and his faithful friends stood their ground admirably; and although, as might have been expected, all were not convinced, these were a very small minority, and public opinion pronounced warmly in favour of the system.

The result was a gigantic stride onward, as many persons of great authority were won over, and an enlarged circle of friends invited Fröbel to Dresden, there to give a half-year's course of instruction to mothers, teachers, and others, who felt interested in early education. About this time, Middendorff wrote a most valuable manual, entitled, *Die Kinder-gärten, Bedürfnisz der Zeit, Grundlage einigender Volkserziehung*. This volume, written in a highly interesting and lucid manner, answered the questions, Why should we have Kinder-gartens? What are they? How do they work, and how do they adapt themselves to the requirements of the times? An appendix contains the opinions of eminent men, and original observations. A new edition of this valuable work appeared in Hamburg, 1861, edited by Dr. Wichard Lange.

In October, 1848, Fröbel went to Dresden. A large number of students gathered round him. Fröbel worked as only a man of such physical strength and vigorous intellect can work. He gave three lectures each day, and not only expounded his principles, but also initiated his pupils into the various occupations of the Kinder-garten. It was during this course at Dresden that the writer of this sketch enjoyed the happiness of sitting at the feet of this great benefactor of his race.

Just before the outbreak of the fearful revolution, March, 1849, Fröbel left Dresden, and went to Bad Liebenstein, near Eisenach. The beautiful scenery, the salubrious air, and the far-famed mineral waters, render this place a favourite retreat, not only with Germans, but also with citizens of other countries. It was not unreasonable to expect successful conquests of public opinion by working the system in the presence of wealthy and intelligent visitors. He was not disappointed. He soon found an enthusiastic admirer of his reformatory plans in a lady whose name we cannot mention but with deep reverence, as it will for ever hold a prominent place in the annals of the Kinder-garten. Frau Baronin Bertha von Marenholtz-Bulow had long been disciplined in the school of affliction, and was thus singularly prepared for the sacred mission that awaited her, and for which she seemed particularly destined, the work of which Fröbel opened to her the portals. With deep insight, with restless energy, and with a heart full of love of mankind, and of children in particular, she eagerly entered upon his plans, and has been to this day the foremost promoter and indefatigable friend of the Kinder-garten. She has been an eloquent and able advocate among the aristocracy and the learned, and her numerous writings form a most important and invaluable part of the literature of the system. Unfettered by family ties, her children being in their own spheres of labour, she has devoted her fortune, her rank and position, her whole life, to the service of what she considered her special mission. Who that is even but slightly acquainted with the movement, has not heard the name of the Baroness von Bulow as the chief among German ladies engaged in the sacred work of primary education?

Another friend made by Fröbel in Liebenstein was Adolph Diesterweg, the present Director of the Royal Seminary for Teachers in Berlin, an educationist whose name most deservedly stands in very high esteem among the teaching profession in Germany. He will ever be remembered as a champion for the liberty of thought, of pure and noble character, and as the chief leader of our time in raising the 'school' in Germany to its present high standard.

Diesterweg was so fascinated with Fröbel that he daily attended his lessons, and confessed himself as exceedingly fortunate in being allowed to be a student at the feet of so great, so rare, and so noble a man. He proved to be his staunchest adherent, and he devoted his enormous influence continuously to the spread and development of the Kinder-garten.

The following winter Fröbel acceded to the call of a ladies' society in Hamburg, to hold a half-year's course similar to that given in Dresden. Middendorff accompanied him, and the new movement made rapid progress in the ancient Hanse city. Fröbel inaugurated there the first national Kinder-garten, the *Bürger Kinder-garten* (bürger, citizen), where, at a small cost, the children of the poorer classes might enjoy the benefits of the system. Gradually this has grown to nine separate institutions, all under one association, and each of them having an attendance of at least a hundred children.

(To be continued.)

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. JOHN LYLE MARTIN.—A man started with a shilling in his pocket. He gambled and won twice as much as he had. He gambled again, and lost $\frac{3}{4}$ of what he then had all but 9d. How much had he then left? Represent your answer as the decimal of a pound.

Amount after first play = 1s. + 2s.
= 3s.;
,, ,, second ,, = $\frac{1}{4}$ of 3s. + 9d.
= 1s. 9d.
= $\frac{1\frac{3}{4}}{20}$ £
= $\frac{7}{80}$ £
= £·0875. Ans.

Note.—Each correspondent is restricted to one question. *Vide* Rule 1 Query Column.

2. INQUISITIVE.—What quantity of each of two sorts of coffee, one at 10d. and the other at 1s. 10d., will when mixed be worth 1s. 2d. per lb.?

Gain on first kind = 1s. 2d. − 10d. = 4d.;
Loss ,, second ,, = 1s. 10d. − 1s. 2d. = 8d.;
∴ Quantity at 10d. : quantity at 1s. 10d. :: 8d. : 4d.
:: 2 : 1. Ans.

Note.—Your writing is *very fair*, but *too straight.*

3. J. THOMPSON.—Which would be the better investment, 3 per cent. stock at 87⅞, or shares at £233 each, on each of which a dividend of £7 13s. 4d. is paid annually? (*Barnard Smith.*)

Income on £1 in first case = $\frac{3}{87\frac{7}{8}}$ £
= $\frac{24}{703}$ £;
,, ,, second ,, = $\frac{7\frac{2}{3}}{233}$ £
= $\frac{23}{699}$ £;

∴ The 3 per cents. at 87⅞ is the better investment.

NOTE.—Each correspondent is restricted to one question. See Rule 1 Query Column.

4. MONITOR.—A tradesman's prices are 25 per cent. above cost price. If he allows a customer 12 per cent. on his bill, what profit does he make? (*All the year round Test Cards.*)

Profit on £100 = £25 − 12 per cent. on £125
= £25 − £15
= £10;
∴ Profit = 10 per cent. Ans.

5. MAGISTER.—A tradesman imported a quantity of foreign goods, for which he had to pay a duty of 15 per cent., but the demand for them having gone off he is obliged to sell at a loss of 5¼ per cent.; a month earlier he could have sold them for £124 4s. more, and then would have cleared at 2½ per cent. on the transaction; what price did he pay for the goods? (*Barnard Smith's* 'Examination Questions in Arithmetic.')

Difference of profits on £100 cost price
= (5¼ + 2½) per cent. on £115
= 8¾ per cent. on £115
= $\left(\frac{\overset{23}{115}}{1} \times \frac{\overset{3}{8\frac{3}{4}}}{\underset{7}{700}}\right)$ £
= £$\frac{69}{70}$;
£ £ £
∴ $\frac{69}{70}$: 124½ :: 100 : Cost price of goods.
= $\left(\frac{\overset{9}{81} \times \overset{20}{100}}{8} \times \frac{7}{249}\right)$ £
= £1,260. Ans.

6. ECCLESBOURNE.—£10,000 in 3½ per cents. is left free of legacy duty to an almshouse for the support of 13 bedesmen. This sum is sold out and re-invested in 4 per cents. at par, legacy duty and transfer expenses amounting to 11¼ per cent. The bedesmen, when the arrangements are completed, receive each £25 2s. $5\frac{1}{13}$d. a year. What was the selling price of the 3½ per cents.? (*Moffatt's* 'Pupil Teachers' Cards.')

Income = £25 2s. $5\frac{1}{13}$d. × 13
= £326 12s.;
Amount invested = £326 12s. × $\frac{100}{3\frac{1}{2}}$
= £326 12s. × 25
= £8,165;
Amount of stock transferred = £10,000 − (£11¼ × 100)
= £10,000 − £1125
= £8875;
£ £ £
∴ 8875 : $\frac{1}{100}$ :: 8165 : Price of 3½ per cents.
355 4 23
= £92.
∴ Price of the 3½ per cents. = 92. Ans.

Note.—Perhaps 80 per cent.

7. LEO.—A person has 4 houses, the united values of which amount to £1,840. The value of the first house is two-thirds of the second, that of the second is three-fourths of the third, and the value of the third is five-sixths of the fourth house: find the value of each. (*Barnard Smith.*)

Value of 3rd house = $\frac{5}{6}$ of value of 4th house;
,, 2nd ,, = $\frac{3}{4}$,, 3rd ,,
= $\frac{3}{4}$ of $\frac{5}{6}$,, 4th ,,
$\frac{2}{}$
= $\frac{5}{8}$,, ,, ,,;
,, 1st ,, = $\frac{2}{3}$,, 2nd ,,
= $\frac{2}{3}$ of $\frac{5}{8}$,, 4th ,,
$\frac{4}{}$
= $\frac{5}{12}$,, ,, ,,;

∴ Value of 4th house × (1 + ⅝ + ⅝ + $\frac{5}{12}$) = £1840,
,, ,, ,, × $\frac{24+20+15+10}{24}$ = ,,;
,, ,, ,, × $\frac{69}{24}$ = £1840,

$\therefore$ Value of 4th house $= £\overset{\beta}{\cancel{1}\cancel{\beta}\cancel{\beta}} \times \frac{8}{\cancel{2}\cancel{5}}$
$= £640$;
" 3rd " $= \frac{1}{5}$ of £640
$= £533$ 6s. 8d.;
" 2nd " $= \frac{1}{5}$ of £640
$= £400$;
" 1st " $= \frac{1}{8}$ of £640
$= £266$ 13s. 4d.

8. LIVERPUDLIAN.—Simplify :—

$3\frac{7}{12}$ of $\frac{4}{11}\frac{3}{7} + 71 + 2\frac{2}{7}$ of $\frac{1}{3}$ of $\frac{1}{4} - \frac{1}{2}\frac{1}{7}$ of $1\frac{1}{11}$. (*Piper.*)

$3\frac{7}{12}$ of $\frac{4}{11}\frac{3}{7} \div 71 + 2\frac{2}{7}$ of $\frac{1}{3}$ of $\frac{1}{4} - \frac{1}{2}\frac{1}{7}$ of $1\frac{1}{11}$

$= \frac{\overset{\beta}{\cancel{4}\cancel{3}}}{\cancel{1}\cancel{2}}$ of $\frac{\overset{\beta}{\cancel{4}\cancel{2}}\cancel{7}}{\cancel{4}\cancel{2}\cancel{7}} \times \frac{1}{7\cancel{1}} + \frac{\overset{\cancel{1}\cancel{1}}{\cancel{7}\cancel{4}}}{70}$ of $\frac{3}{\cancel{8}\cancel{3}}$ of $\frac{\cancel{8}}{\cancel{4}\cancel{4}} - \frac{7}{\cancel{1}\cancel{9}\cancel{8}}$ of $\frac{9\cancel{1}}{\cancel{1}\cancel{4}}$

$= \frac{1}{3\cancel{1}} + \frac{1}{2\cancel{1}\cancel{2}} - \frac{1}{2\cancel{1}}$

$= \frac{40 + 9 - 35}{840}$

$= \frac{1\cancel{4}}{8\cancel{4}\cancel{0}}$

$= \frac{1}{6\cancel{0}}$. Ans.

9. DISAPPOINTED.—A, B, and C run a quarter of a mile race. A has 3 yards' start, and B 2 yards. C gains one foot in 40 yards throughout on A. B gains 2 ft. in 25 yds. on A for the first 200 yds., and then loses 1 foot in 20 yds. What is the result of the race?

C's gain on A $= 4\frac{4}{4}\frac{0}{0}$ ft. $= 11$ ft.;
$\therefore$ C is 11 ft. $- 3$ yds., or 2 ft. in front of A;
B's gain on A $= (\frac{2}{2}\frac{0}{5}\frac{0}{0} \times 2)$ ft. $- 2\frac{1}{2}\frac{0}{0}$ ft.
$= 16$ ft. $- 11\frac{1}{2}\frac{0}{0}$ ft.
$= 4\frac{1}{2}\frac{9}{0}$ ft.;
$\therefore$ B is $4\frac{1}{2}\frac{9}{0}$ ft. $- 1$ yd., or $1\frac{1}{2}\frac{9}{0}$ ft. in front of A;
$\therefore$ Result is :—
C first, 2 ft. in front of A., and $\frac{9}{2}\frac{}{0}$ ft. before B; B second, $1\frac{1}{2}\frac{9}{0}$ ft. in front of A.

10. HOPEFUL.—A train 88 yards in length overtook a person walking along the line at the rate of 4 miles an hour, and passed him in 10 seconds. Twenty minutes after the train overtook another person, and passed him in 9 seconds. When will the last person overtake the first? (*Barnard Smith.*)

Distance walked by last person in 10 seconds
$= \left(\frac{1\overset{3}{\cancel{8}}}{\cancel{8}\cancel{8} \times \cancel{8}\cancel{8}} \text{ of } \overset{3}{\cancel{4}} \times 176\overset{3}{\cancel{0}}\right)$ yds.
$= 1\frac{7}{2}\frac{3}{2}$ yds.
$= 19\frac{1}{2}$ yds.;
Distance travelled by train in 10 seconds
$= (88 + 19\frac{1}{2})$ yds.
$= 107\frac{1}{2}$ yds.;
Distance travelled by train in 9 seconds
$= (107\frac{1}{2} \times \frac{9}{1\cancel{0}})$ yds.
$= \frac{9}{2}\frac{6}{0}\frac{3}{0}$ yds.
$= 96\frac{3}{4}$ yds.;
$\therefore$ Distance walked by first person in 9 seconds
$= (96\frac{3}{4} - 88)$ yds.
$= 8\frac{3}{4}$ yds.;
$\therefore$ Rate per hour of first person
$= \left(8\frac{3}{4} \times \frac{60 \times 60}{9}\right)$ yds.
$= \left(\frac{\overset{2}{\cancel{3}\cancel{5}}}{\cancel{4}} \times \frac{\overset{\cancel{1}\cancel{0}}{\cancel{6}\cancel{0}\cancel{0}}}{\cancel{1}\cancel{7}\cancel{6}\cancel{0}}\right)$ miles
$= 2$ miles;

Distance between the two persons when the train overtook the first person
$= \left(107\frac{1}{2} \times \frac{60 \times 20}{10}\right)$ yds. $- \frac{2}{8}\frac{2}{0}$ of $(4 - 2)$ miles
$= \left(\frac{\overset{22}{\cancel{9}\cancel{8}\cancel{0}}}{\cancel{9}} \times \frac{\overset{2}{\cancel{2}\cancel{0}\cancel{0}}}{\cancel{1}\cancel{7}\cancel{6}\cancel{0}}\right)$ miles $- \frac{1}{5}$ of 2 miles
$= 7\frac{3}{4}$ miles $- \frac{2}{5}$ mile
$= 6\frac{3}{4}$ miles;

$\therefore$ Time last person will overtake the first after train has passed first person
$= (6\frac{3}{4}$ miles $\div 2$ miles) hours
$= \frac{3}{4}\frac{3}{0}$ hours
$= 3\frac{3}{4}$ hours. Ans.

11. INQUISITIVE.—Given the rate of exchange as 25·22 francs per £ sterling, and that 4·54 litres are equivalent to one gallon—deduce the number of francs per litre equivalent to one shilling per gallon. (*Edinburgh University Senior Local Exam.*, 1884-5.)

Quantity for £1 $= 20$ gals.
$= (20 \times 4{\cdot}54)$ litres;
Quantity for 25·22 francs $= (20 \times 4{\cdot}54)$ litres;
$\therefore$ Price per litre $= \frac{\overset{12{\cdot}61}{\cancel{2}\cancel{5}{\cdot}\cancel{2}\cancel{2}}}{\cancel{2}\cancel{0} \times 4{\cdot}54}$ of a franc
$= \frac{12{\cdot}61}{45{\cdot}4}$ of a franc
$= {\cdot}27775\ldots$ of a franc. Ans.

12. P. T. L.—If the estimated value of the property in a certain parish consist of the yearly rent paid to the landlord together with the rates, and the rates be calculated upon the rent after a reduction of 30 per cent., find the rateable value of a tithe-rent charge, the estimated annual value of which is £884, when the rates amount to 3s. in the pound. (*Barnard Smith.*)

Estimated annual value $=$ Rent + Rates;
$\therefore$ £884 $=$ Rent + Rates
$=$ Rent + Rate on (Rent $- 30\%$ of Rent)
$=$ Rent + Rate on $\frac{7}{1\cancel{0}}$ of Rent
$=$ Rent + Rate of 3s. in the £ on $\frac{7}{1\cancel{0}}$ of Rent
$=$ Rent + $\frac{3}{2\cancel{0}}$ of $\frac{7}{1\cancel{0}}$ of Rent
$=$ Rent + $\frac{2\cancel{1}}{1\cancel{0}\cancel{0}}$ of Rent
$= \frac{1\cancel{2}\cancel{1}}{1\cancel{0}\cancel{0}}$ of Rent;
$\therefore$ Rent $= £884 \div \frac{1\cancel{2}\cancel{1}}{1\cancel{0}\cancel{0}}$
$= £800$;
$\therefore$ Rateable value $= \frac{7}{1\cancel{0}}$ of £800
$= £560$. Ans.

13. CURIOUS.—If a concert costing £25, and attended by 250 people, produce a profit of $£4\frac{1}{2}\frac{}{0}$, what would be the profit of one costing £10 more, attended by $\frac{1}{5}$ more people at $\frac{1}{5}$ higher prices? (*Davis.*)

Amount realised by second concert
$= £(25 + 4\frac{1}{1\cancel{7}}) \times \frac{\overset{2}{\cancel{6}}}{\cancel{5}} \times \frac{4}{\cancel{3}}$
$= £29\frac{4}{1\cancel{7}} \times \frac{2}{1}$
$= (£\frac{5\cancel{8}}{1\cancel{7}} \times \frac{2}{1})$
$= £\frac{4\cancel{6}\cancel{8}}{1\cancel{7}\cancel{1}}$
$= £47$ 18s. $1\frac{7}{1\cancel{7}}$d.;
$\therefore$ Profit of second concert $= £47$ 18s. $1\frac{7}{1\cancel{7}}$d.
$- (£25 + £10)$
$= £47$ 18s. $1\frac{7}{1\cancel{7}}$d. $- £35$
$= £12$ 18s. $1\frac{7}{1\cancel{7}}$d. Ans.

Note.—Perhaps 90 per cent.

14. COLUMBA.—If, when 25 per cent. is lost in grinding wheat, a country has to import ten million quarters, but can maintain itself on its own produce, if only 5 per cent. be lost, find the quantity of wheat grown in the country. (*Barnard Smith.*)

Quantity grown $=$ Ten million quarters $\times \frac{100}{25 - 5}$
$=$ " " " $\times \frac{1\cancel{0}\cancel{0}}{2\cancel{0}}$
$=$ " " " $\times 5$
$=$ Fifty million quarters. Ans.

15. FRANCHISE.—A dishonest publican uses measures which are false to the extent of 5 per cent.; but his brewer gave him in every barrel only 35 gallons. The publican buys at 21s. the barrel, and sells at 2d. the pint; what does he gain in a year when he bought 950 gallons? (*Piper.*)

Gain on a barrel $= [\{(35 \times 8) \div \frac{3\cancel{5}}{1\cancel{0}\cancel{0}}\} \times 2]$d. $-$ 21s.
$= \left(2\frac{1}{1}\frac{0}{9} \times \frac{\overset{10}{\cancel{2}\cancel{0}}}{19} \times \frac{1}{\overset{3}{\cancel{6}}}\right)$s. $-$ 21s.

$$= \frac{2800 - 1197}{57}\text{s.}$$
$$= \frac{1603}{57}\text{s.};$$

$$\therefore \text{Gain on 950 barrels} = \left(\frac{1603}{57} \times \frac{950}{1}\right)\text{s.}$$
$$= 28\frac{1}{3}{}^{50}\text{s.}$$
$$= 26,716\tfrac{2}{3}\text{s.}$$
$$= \underline{£1,335\ 16\text{s. } 8\text{d.}}\ \text{Ans.}$$

16. F. S.—A person sells out of the new 3 per cents. at 93¼ as much stock as produces £26,893 6s. At what price must the Turkish 6 per cents. be, in order that by investing the proceeds in it, he may increase his income by £200 a year, taking brokerage into account? (*Clark's* 'Civil Service Arithmetic.')

£ 93¼ : £ 26893 6 s. :: £ 100 : £ Amount of stock sold out.

20 | 20 | 20

1866 | 537866 | 273 | 1442

$$= \underline{£28,840 \text{ stock.}}$$

Income from Turkish 6 per cents.
$= 3$ per cent. on £28,840 + £200
$= £865\ 4\text{s.} + £200$
$= \underline{£1065\ 4\text{s.}}$

£ 1065 4 : £ 3 :: £ 26893 6 : Price of Turkish stock with brokerage.

20 | 20

21284 | 537866

5326 | 268933 | 3

)806799(£151 4/5

5326

27419

26630

7899

5326

2573

∴ Price of Turkish 6 per cents.
$= 151\frac{4}{5} - \frac{1}{3}$
$= 151\frac{10292 - 2663}{21304}$
$= \underline{151\frac{7629}{21304}}.$ Ans.

Algebra

1. ASSISTANT.—Solve:—
$$2^{x+1} + 4^x = 80. \quad (\textit{Todhunter.})$$
$$2^{x+1} + 4^x = 80$$
(Put y for 2^x)
Then, $2y + y^2 = 80$
$y^2 + 2y + 1 = 81$
$y + 1 = \pm 9$
$\therefore \underline{y = 8, \text{ or } -10.}$
$\therefore 2^x = 8, \text{ or } -10,$
so that $\underline{x = 3.}$

2. REX.—A house of 11 boys contains 6 who can only row, and 3 who can only steer; the other 2 can do either. How many different crews can they form for their four-oar? (*Dalton.*)

No. of crews from the 6 who can only row and from the 3 who can only steer $= \frac{6.5.4}{1.2.3} \times 3$
$= 60;$

No. of crews from the 6 who can only row and from the 2 who can do either to steer $= \frac{6.5.4}{1.2.3} \times 2$
$= 40;$

No. of crews from 2 out of the 6 who can only row, from the 2 who can do either, and from the 3 who can only steer $= \frac{6.5}{1.2} \times 2 \times 3$
$= 90;$

No. of crews from 2 out of the 6 who can only row and from the 2 who can do either, 1 to steer and 1 to row $= \frac{6.5}{1.2} \times 2$
$= 30;$

No. of crews from 1 out of the 6 who can only row, from the 2 who can do either, and from the 3 who can only steer $= 6 \times 3$
$= 18;$
$\therefore$ No. of different crews $= 60 + 40 + 90 + 30 + 18$
$= \underline{238.}$

3. E. P. JONES.—Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be determined by simple division. (*Certificate*, 1883.)

Let N represent the no. whose square root is required, a the part of the root already obtained, and x the part which remains to be found; then

Squaring, $\sqrt{N} = a + x,$
$N = a^2 + 2ax + x^2,$
$N - a^2 = 2ax + x^2,$
$\frac{N - a^2}{2a} = x + \frac{x^2}{2a}.$

Thus $N - a^2$ divided by $2a$ will give the rest of the square root required, or x, increased by $\frac{x^2}{2a}$, and $\frac{x^2}{2a}$ is a proper fraction, so that by neglecting the remainder arising from the division we obtain the proof required.

For x by supposition contains n digits, so that x^2 cannot contain more than $2n$ digits; and a contains $n+1$ digits, therefore $\frac{x^2}{2a}$ is a proper fraction.

4. JULIUS CÆSAR.—Solve:—
$$x + y = 7(x - y),\ x^2 + y^2 = 100.$$
—(*Todhunter's* 'Algebra for Beginners.')

(1) $x + y = 7(x - y)$
(2) $x^2 + y^2 = 100$
(1) $x + y = 7(x - y)$
$= 7x - 7y$
$8y = 6x$
$\therefore \underline{y = \frac{3x}{4}.}$

Substituting this value of y in (2): (2) $x^2 + \left(\frac{3x}{4}\right)^2 = 100$

$x^2 + \frac{9x^2}{16} = 100$
$\frac{25x^2}{16} = 100$
$x^2 = 64$
$\therefore \underline{x = \pm 8.}$
$y = \frac{3x}{4}$
$= \frac{\pm 8 \times 3}{4}$
$= \underline{\pm 6.}$

Note.—Various artifices are employed in solving 'Simultaneous Equations involving quadratics,' and the proper application of the different methods must be learned by experience. The simplest method is by substitution, as in the given example.

5. C. J. S.—Solve:—
$$\sqrt{x^2 - 6x + 16} + (x - 3)^2 = 13. \quad (\textit{Todhunter.})$$
$$\sqrt{x^2 - 6x + 16} + (x - 3)^2 = 13$$
$$\sqrt{x^2 - 6x + 16} + (x^2 - 6x + 9) = 13$$
Adding 7 to each side:
$(x^2 - 6x + 16) + \sqrt{x^2 - 6x + 16} = 13 + 7$
$= 20$
Completing the square:
$(x^2 - 6x + 16) + \sqrt{x^2 - 6x + 16} + (\frac{1}{2})^2 = 20 + \frac{1}{4}$
$= \frac{81}{4}$
$\sqrt{x^2 - 6x + 16} + \frac{1}{2} = \pm\frac{9}{2}$
$\sqrt{x^2 - 6x + 16} = \pm\frac{9}{2} - \frac{1}{2}$
$= 4, \text{ or } -5$
Squaring each side, $x^2 - 6x + 16 = 16, \text{ or } 25;$
$x^2 - 6x + 16 = 16$
$x^2 - 6x = 0$
Dividing each side by x, $x^2 = 6x$
$\therefore \underline{x = 6;}$

And as we divide each side by x, therefore the value $x = 0$ satisfies the equation.

From, $x^2-6x+16=25$, surd values of x are obtained, and they do not satisfy the equation.

$\therefore$ $x=0$, or 6.

6. J. EDWARDS.—Divide 418·9666 by 6·289 in scale of 12. Reduce 296·7 from scale of 12 to that of 10. Find value in decimals of ·1$\frac{5}{}$ in the scale of 7. (*Lower Division*, February, 1883.)

(1) 6 289) 418·9666 (7c·t. Ans.
377 13
61 836
58 603
5 2336
5 2336

(2) 10 | 296 ·7 in scale of 12
10 | 34 ...2 $=\frac{7}{12}$ in scale of 10
4 ...0 $=$ ·583;

$\therefore$ 296·7 in scale of 12 = 402·583 in scale of 10.

(3) ·1$\frac{5}{}$ in scale of 7

$=\frac{1}{7}+\frac{5}{7^2}+\frac{5}{7^3}+\frac{5}{7^4}$.....

Here the terms after the first constitute an infinite Geometrical Progression, of which the first term is $\frac{5}{7^2}$, and the common ratio is $\frac{1}{7}$.

Sum of an infinite geometrical series

$=\frac{a}{1-r}$

$=\frac{5}{7^2}\div(1-\frac{1}{7})$

$=\frac{5}{7^2}\div\frac{6}{7}$

$=\frac{5}{7\times6}$

$=\frac{5}{42}$;

$\therefore$ ·1$\frac{5}{}$ in scale of 7 $=\frac{1}{7}+\frac{5}{42}=\frac{11}{42}$
$=$ ·26190476 in common scale.

Note.—The subject of 'Scales of Notation' is generally contained in works on Algebra.

7. E. H. COUMBE.—'The square of any real number, positive or negative, is always positive':—Hence show that $a^2c^2+b^2d^2$ is always greater than $2abcd$, and that $\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$ is always a proper fraction, whatever values may be assigned to a, b, c, d.

$(ac-bd)^2$ always gives a positive quantity,
$\therefore$ $(a^2c^2-2abcd+b^2d^2)$ = positive quantity,
$\therefore$ $a^2c^2+b^2d^2>2abcd$.

Note.—When $ac=bd$, then $a^2c^2+b^2d^2=2abcd$.

$$\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$$
$$=\frac{a^2c^2+2abcd+b^2d^2}{a^2c^2+a^2d^2+b^2c^2+b^2d^2}$$
$$=\frac{(a^2c^2+b^2d^2)+2abcd}{(a^2c^2+b^2d^2)+(a^2d^2+b^2c^2)}$$

Now, if $ac=bd$, ad cannot equal bc,
$\therefore$ $a^2d^2+b^2c^2>2abcd$ (as above)

$\therefore$ $\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$ is always a proper fraction.

8. R. R. P.—The population of a town increases annually by 4 per cent.; what proportionate addition to the population will be made in a period of 10 years?

N.B. Log. 1·04 = ·017033;
log. 1·48 = ·170330. (*Certificate*, 1883.)

Population at end of 10 years = Population at beginning of 1st year $\times(1\cdot04)^{10}$
= Population × No. corresponding to log (10 times log. 1·04)
= Population × No. corresponding to log. (·017033 × 10)
= Population × No. corresponding to log. ·170330
= Population × 1·48;
$\therefore$ Proportionate addition = ·48 = $\frac{12}{25}$.

Note.—It is not necessary to take Mental Arithmetic, but if you do it will increase the number of marks.

9. ANFEDRUS.—Prove by induction or otherwise the sum of the series

$$1^3+2^3+\ldots\ldots+m^3=\frac{m^2(m+1)^2}{4}.$$

—(*Certificate*, 1883.)

Let s denote the required sum; then

$s=1^3+2^3+\ldots\ldots+m^3$;

We have

$m^4-(m-1)^4=4m^3-6m^2+4m-1$,
$(m-1)^4-(m-2)^4=4(m-1)^3-6(m-1)^2+4(m-1)-1$,
$(m-2)^4-(m-3)^4=4(m-2)^3-6(m-2)+4(m-2)-1$,
.....
$3^4-2^4=4\cdot3^3-6\cdot3^2+4\cdot3-1$,
$2^4-1^4=4\cdot2^3-6\cdot2^2+4\cdot2-1$,
$1^4-0^4=4\cdot1^3-6\cdot1^2+4\cdot1-1$;

Hence, by addition,

$m^4=4\{1^3+2^3+\ldots\ldots+m^3\}$
$-6\{1^2+2^2+\ldots\ldots+m^2\}$
$+4\{1+2+\ldots\ldots+m\}-m$;

The sum of the squares of the first m natural numbers $=\frac{m(m+1)(2m+1)}{6}$;

The sum of the first m natural numbers $=\frac{m}{2}(m+1)$;

That is, $m^4=4s-m(m+1)(2m+1)+2m(m+1)-m$
$=4s-2m^3-3m^2-m+2m^2+2m-m$
$=4s-2m^3-m^2$,
$4s=m^4+2m^3+m^2$
$=m^2(m^2+2m+1)$
$=m^2(m+1)^2$
$\therefore$ $s=\frac{m^2(m+1)^2}{4}$.

10. J. HOLTON.—Solve:—

$$\left.\begin{array}{l}(x+5)^2+(y-6)^2=2(xy-24)\\ y=x+1\end{array}\right\}\text{(Colenso.)}$$

(1) $(x+5)^2+(y-6)^2=2(xy-24)$
(2) $y=x+1$

Substituting in (1) value of y from (2) $\}$ $(x+5)^2+(x-5)^2=2\{x(x+1)-24\}$
$x^2+10x+25+x^2-10x+25=2\{x^2+x-24\}$
$2x^2+50=2x^2+2x-48$
$-2x=-48-50$
$2x=98$
$\therefore$ $x=49$.
$y=x+1=50$.

11. CHRISTIE JOHNSTONE.—What relation must hold good between p, q, and n, if x^n-px+q and $nx^{n-1}-p$ have a common measure?

$nx^{n-1}-p=n\left(x^{n-1}-\frac{p}{n}\right)$;

$$\begin{array}{l}x^{n-1}-\frac{p}{n}\Big)\,x^n-px+q\,\Big(x-p\left(1-\frac{1}{n}\right)\\ \quad x^n-\frac{p}{n}x\\ \hline \quad -p\left(1-\frac{1}{n}\right)x+q\\ \quad -p\left(1-\frac{1}{n}\right)x^{n-1}+\frac{p^2}{n}\left(1-\frac{1}{n}\right)\\ \hline\end{array}$$

$\therefore$ $n-1$ must equal 1,
That is, n must equal 2;

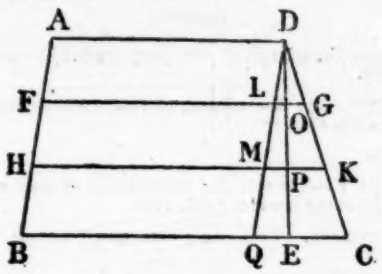
q must equal $\frac{p^2}{n}\left(1-\frac{1}{n}\right)$,
q " " $\frac{p^2(n-1)}{n^2}$,
q " " $\frac{p^2(2-1)}{2^2}$,
q " " $\frac{p^2}{4}$;

$\therefore$ They will have a common measure if $n=2$, and $q=\frac{p^2}{4}$, and the common measure will be $\left(x-\frac{p}{2}\right)$.

Mensuration.

1. TIM.—The parallel sides of a trapezoid are 14 yards and 20 yards, and the perpendicular distance is 12 yards. If two straight lines are drawn across the figure parallel to the parallel sides, and dividing each of the other sides into three equal parts, find the areas of the three parts into which the trapezoid is divided. (*Todhunter.*)

Let ABCD represent the trapezoid, and let FG, HK be drawn dividing AB, DC into three equal parts.



Also let DQ be drawn parallel to AB, and DE perpendicular to BC.

Then DQ, DE will be trisected by FG, HK.

$$LG = \tfrac{1}{3} \text{ of } QC = \tfrac{1}{3} \text{ of } (BC - AD)$$
$$= \tfrac{1}{3} \text{ of } (20 - 14) = \tfrac{1}{3} \text{ of } 6 = 2 \text{ ; } \therefore FG = 16 \text{ ;}$$
$$MK = \tfrac{2}{3} \text{ of } QC = \tfrac{2}{3} \text{ of } 6 = 4 \text{ ; } \therefore HK = 18 \text{ ;}$$
$$DO, OP, PE = \tfrac{1}{3} \text{ of } DE = \tfrac{1}{3} \text{ of } 12 = 4 \text{ ;}$$
$$\text{Area of AFGD} = \frac{AD + FG}{2} \times DO$$
$$= \frac{14 + 16}{2} \times 4$$
$$= 30 \times 2$$
$$= 60 \text{ ;}$$
$$\text{,, ,, FHKG} = \frac{FG + HK}{2} \times OP$$
$$= \frac{16 + 18}{2} \times 4$$
$$= 34 \times 2$$
$$= 68 \text{ ;}$$
$$\text{,, ,, HBCK} = \frac{HK + BC}{2} \times PE$$
$$= \frac{18 + 20}{2} \times 4$$
$$= 38 \times 2$$
$$= 76 \text{ ;}$$

Areas of the three parts = 60, 68, and 76 yards respectively.

2. M. S.—A rectangular courtyard is 100 feet long and 60 broad. Two paths cross it at right angles, one from end to end, and the other from side to side. Each of these is 5 feet wide. Find the cost of laying down the remaining area with turf, at sixpence per square yard. (*Oxford Local Examination*, 1884.)

There are four rectangular parts to be turfed, the dimensions of which are

$$\frac{100 - 5}{2} \text{ ft. and } \frac{60 - 5}{2} \text{ ft. ;}$$

$$\therefore \text{ Parts to be turfed} = \left(\frac{95}{\cancel{2}} \times \frac{55}{\cancel{2}} \times \frac{\cancel{4}}{1}\right) \text{ sq. ft.}$$
$$= 5225 \text{ sq. ft.}$$
$$\therefore \text{ Cost} = (5225 \times \tfrac{1}{2})\text{s.}$$
$$= 2612\tfrac{1}{2}\text{s.}$$
$$= 290\tfrac{5}{12}\text{s.}$$
$$= £14 \text{ 10s. } 3\tfrac{1}{2}\text{d. Ans.}$$

3. CARELESS.—A conic frustrum contains 3½ gallons, the diameters of the two ends being respectively 10 in. and 6 in. Suppose a gallon contains 277·274 cub. in., find the depth of the frustrum.

If a^2 and b^2 be the areas of the two ends of a conic frustrum, and h the perpendicular height,

$$\text{Volume} = \frac{h}{3}(a^2 + ab + b^2) \text{ ;}$$

$$\therefore \frac{h}{3}(a^2 + ab + b^2) = (277{\cdot}274 \times 3\tfrac{1}{2}) \text{ cub. in.}$$

$$\frac{h}{3}\left\{(10^2 + 10 \times 6 + 6^2) \times {\cdot}7854\right\} \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$
$$\frac{h}{3}\left\{(100 + 60 + 36) \times {\cdot}7854\right\} \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$
$$\frac{h}{3}(196 \times {\cdot}7854) \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$
$$\therefore h = \frac{138{\cdot}637}{\cancel{196} \times {\cdot}2618} \text{ in.}$$
$$= \frac{138{\cdot}637}{7{\cdot}3304} \text{ in.}$$
$$= 18{\cdot}912\ldots \text{in. ;}$$
$$\therefore \text{ Depth of frustrum} = 1 \text{ ft. } 6{\cdot}912\ldots \text{in.}$$

4. CELT.—Find the content of a ring whose section is 9 inches square, and outside diameter 6 feet.

$$\text{Inside diameter} = 6 \text{ ft.} - (9 \text{ in.} \times 2)$$
$$= 4\tfrac{1}{2} \text{ ft. ;}$$
$$\therefore \text{ Content of ring} = [\{6^2 - (4\tfrac{1}{2})^2\} \times {\cdot}7854] \text{ sq. ft.} \times 9 \text{ in.}$$
$$= \{(6 + 4\tfrac{1}{2})(6 - 4\tfrac{1}{2}) \times {\cdot}7854 \times \tfrac{3}{4}\} \text{ cub. ft.}$$
$$= \left(\frac{21}{\cancel{2}} \times \frac{\cancel{3}}{\cancel{4}} \times \frac{\cancel{3}}{\cancel{4}} \times \frac{{\cdot}3927}{{\cdot}7854}\right) \text{ cub. ft.}$$
$$= \frac{74{\cdot}2203}{8} \text{ cub. ft.}$$
$$= 9{\cdot}2775375 \text{ cub. ft.}$$
$$= 9 \text{ cub. ft. } 479{\cdot}5848 \text{ in. Ans.}$$

Note.—(1) You will notice that 9 in. only instead of twice 9 in. was subtracted from 6 ft. to obtain the inner diameter. (2) 'Section 9 inches square' means that if the ring were cut, the section would be a square with side 9 inches.

5. BORDERER.—What is the height of a parallelogram whose base is 242 yards and area 3½ acres? (*P. T. Examination.*)

$$\text{Area} = \text{base} \times \text{perpendicular height ;}$$
$$\therefore 242 \text{ yds.} \times \text{perpendicular height} = 3\tfrac{1}{2} \text{ acres}$$
$$= \frac{7 \times 4840}{2} \text{ sq. yds.}$$
$$= 16940 \text{ sq. yds. ;}$$
$$\therefore \text{ Perpendicular height} = \frac{16940}{242} \text{ yds.}$$
$$= 70 \text{ yds. Ans.}$$

Note.—Perhaps 90 per cent.

6. YELLSERP.—Find the area of a regular polygon of 24 sides inscribed in a circle, the radius of which is one foot. (*Todhunter.*)

$$\text{Area of polygon} = \frac{n}{2} R^2 \sin \frac{2\pi}{n},$$

where n = No. of sides, R = Radius of circumscribed circle, and $2\pi = 4$ right angles;

$$\therefore \text{ Area of polygon of 24 sides}$$
$$= \left(\frac{24}{2} \times 1^2 \times \sin\frac{360^\circ}{24}\right) \text{ sq. ft.}$$
$$= (12 \times \sin 15^\circ) \text{ sq. ft.}$$
$$= \left(12 \times \frac{\sqrt{3} - 1}{2\sqrt{2}}\right) \text{ sq. ft.}$$
$$= \frac{12(\sqrt{6} - \sqrt{2})}{2 \times 2} \text{ sq. ft.}$$
$$= \{3(\sqrt{6} - \sqrt{2})\} \text{ sq. ft.}$$
$$= (\sqrt{54} - \sqrt{18}) \text{ sq. ft.}$$
$$= (7{\cdot}34846\ldots - 4{\cdot}24264\ldots) \text{ sq. ft.}$$
$$= 3{\cdot}10582\ldots \text{sq. ft. Ans.}$$

7. M. R. S.—Find the dimensions of a rectangular cistern, whose base is a square and height equal to half the length of one side of the base, and which contains 53,000 gallons, each gallon being equal to 277·274 cubic inches. (*Civil Service Arithmetic.*)

$$\text{Length}^3 \times \tfrac{1}{2} \text{ Length} = (277{\cdot}274 \times 53{,}000) \text{ cub. in.}$$
$$\tfrac{1}{2} \text{ Length}^3 = 14{,}695{,}522 \text{ cub. in.,}$$
$$\text{Length}^3 = 29{,}391{,}044 \text{ cub. in.,}$$

Length = $\sqrt[3]{29,391,044}$ cub. in.

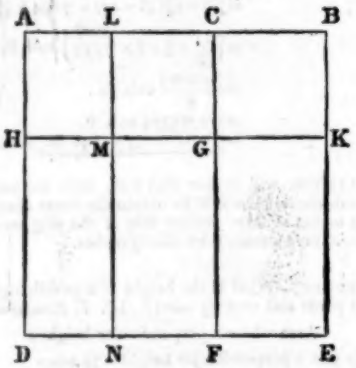
29'391'044(308·6
27

$30^2 \times 300 = 270000$	2391044
$30 \times 8 \times 30 = 7200$	
$8^2 = 64$	
277264	2218112
$308^2 \times 300 = 28459200$	172932000
$308 \times 6 \times 30 = 55440$	
$6^2 = 36$	
28514676	171088056
	1843944

∴ Length = 308·6 in.
= 25·7 ft.
Depth = 12·8 ft.

Geometry.

1. BOLDMERE.—A straight line is divided into two parts; show that if twice the rectangle of the parts is equal to the sum of the squares described on the parts, the straight line is bisected. (*Todhunter.*)



Let the straight line AB be divided into two parts at the point C, and let the squares on AC and CB be equal to twice the rectangle AC.CB; then shall AB be bisected at C.

For if AC be not equal to CB, suppose AC the greater, and construct the diagram of II. 4.

From CA cut off CL equal to CB, and through L draw a straight line parallel to AD, meeting HG at M and DE at N.

Proof.—The squares HF and CK are together equal to the rectangles AG and GE, and MF has been made equal to GE,

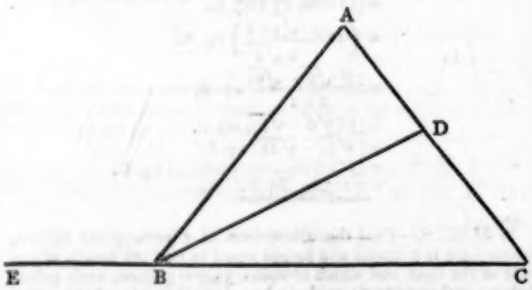
∴ HN and CK are equal to AG,
and LG has been made equal to CK,
∴ HN is equal to AM;

But this is impossible, for HD is greater than AH.

Hence AC and CB cannot be unequal, that is, they are equal.

Q. E. D.

2. TEMPEST.—If a line intercepted between the extremity of the base of an isosceles triangle and the opposite side (produced if necessary) be equal to a side of the triangle, the angle formed by this line and the base produced is equal to three times either of the equal angles of the triangle.



Let ABC be an isosceles triangle, and let BD be drawn equal to BA or AC, then the angle DBE shall be equal to three times the angle ABC or the angle ACB.

Proof.— ∠ DBE = ∠s ABE, ABD,
∠ ABE = ∠s BAC, ACB, (I. 32.)
and ∠ BAC or BAD = ∠ BDA, (I. 5.)
∴ ∠ DBE = ∠s BDA, ACB, ABD;
but ∠ BDA = ∠s DBC, DCB or ACB,
∴ ∠ DBE = ∠s DBC, ABD, and twice ∠ ACB;
and ∠s DBC, ABD = ∠ ABC;
∴ ∠ DBE = ∠ ABC, and twice ∠ ACB
= 3 times ∠ ABC or ∠ ACB.

Note.—If the triangle be acute-angled, the enunciation of the proposition requires some modification. Q. E. D.

General.

1. BOZ.—The solution of your query appeared in our issue for May, 1882.

2. UNITY.—(1) The solution of your query appeared in our issue for July, 1882.

(2) Yes.

3. O. H. F.—You will find the solution of your query (by arithmetic) in our issue for April, 1882.

4. TOTNESIAN.—Your query was solved in our issue for April, 1883.

5. E. H.—From the second equation the values of y are 0, and $x-3$. Substituting the former in the first equation, it becomes:—

$$x^{\frac{3}{2}} + x - 4x^{\frac{1}{2}} = 2;$$

and substituting the latter value, it is:—

$$x^2 - x^{\frac{3}{2}} - 6x + 4x^{\frac{1}{2}} = -8.$$

6. N. H. B.—(1) The deduction was solved in our issue for June, 1882. (2) It is impossible when the three given lines are parallel.

7. NIGER.—Your solution is simple and correct.

8. PROFESSOR P.—(1) You will find the solution of your query in our issue for May, 1883. (2) Perhaps 65 per cent. Your writing is not regular.

9. T. D.—The word preceding is not in the code. See 'Code,' article 57, *b* (2).

10. THEOPHILUS H. C. SHAW.—You do not state the temperature of the ice nor the coefficient of expansion of the glass used. If a be the coefficient of expansion and O° C, be the temperature of the ice, then the length will be $15(1+200a)$. If L = the length at temperature t, then the length at temperature T is $L\{1+a(T-t)\}$.

11. ANXIOUS.—*Mackay's* 'Geography,' *Lawson's* 'Geography,' *Green's* 'Smaller History,' or the 'Student's Hume.' These are well-known books, to be had through any bookseller.

12. BEGINNER.—Move hand and paper as you like. Dotted lines are useful at first, but should be gradually dispensed with. Try Yule's books.

13. OLIVER.—You can take 1st year's papers, but only a third-class certificate will be issued. See Code, art. 66.

14. INJURED.—(1) Yes; Code, art. 58. (2) No. (3) If you received the notice previously agreed upon there appears to be no injustice done and no cause of complaint as to that special point.

15. JEAN.—Under art. 58 of the Code it would seem that all you want is a recommendation from the elementary school in which you last served.

16. SISSY.—We have made several inquiries, but fear there is no remedy.

17. ALDYTH.—See the display of the Birmingham School Board in the Health Exhibition.

18. IXION.—Both may be correct; to decide which, one must see the context. Consult any good grammar.

19. YELLSERP.—Marks are given for one Science only; see Code, Schedule v., column 10. The remark you quote referred to the Certificate Examination, in which more marks are given for a science than for geography or history.

20. DON QUIXOTE.—Small hand is very good, with exception of the capital, which is decidedly poor. Large hand is also good, except the capitals. Value of each without the capitals 90, with the capitals 80.

21. J. P.—The resultant of any two forces P and Q acting at an angle α can always be found by the following formula :—

$R^2 = P^2 + Q^2 + 2PQ \cos \alpha$. By the terms of the question, R is twice P, and the angle α is 30 degrees. Hence

$$4 = 1 + Q^2 + 2Q\frac{\sqrt{3}}{2}.$$

$$\therefore Q^2 + Q\sqrt{3} = 3.$$

$$\therefore Q^2 + Q\sqrt{3} + \tfrac{3}{4} = \tfrac{15}{4}, \text{ whence } Q = \frac{\sqrt{15}}{2} - \frac{\sqrt{3}}{2}$$

$$= \frac{\sqrt{3}}{2}(\sqrt{5} - 1)$$

$$1 : \frac{\sqrt{3}}{2}(\sqrt{5} - 1). \text{ Ans.}$$

22. BELL.—The answer to the question is No—at least, not officially.

23. JAMES GUILD.—Small-handwriting is very good. It ought to bring 90 per cent. The large-handwriting is equally good in shape; the strokes have ragged edges, and in some cases there are evidences of painting. Use a broader-pointed pen.

24. ROMEO.—Small hand good. 85 per cent. The large hand is poor in shape throughout. 50 per cent.

25. CLARA.—The questions are published, you can most likely get them through a bookseller.

26. H.—Cemmerii were described by Homer as living beyond the ocean stream where the sun never shines. Later writers placed them either in Italy near the Avernus, or in the Tauric Chersonese.

27. ISAAC BARRETT.—The rooms were often called after the colour of the furniture and hangings, so in this case. In the second allusion, quatre of course means four; deuce-ace is a throw of two dice, one of which turns up one and the other two. Compare Shakespeare's 'Love's Labour Lost,' scene ii.

28. J. GAUKROGER.—One counts as much as the other. Finally, you will have to learn both. See reply to Resiart ap Ifan.

29. RESIART AP IFAN.—Marks are given to any candidate who has taken a first-class Elementary Stage, or passed in the Advanced Stage of *one* of eight subjects; see Code Schedule, paragraph 10.

30. WAMBRA.—The parsing of *work* depends upon the method of supplying the ellipsis. It may be supplied thus :—'I must work'—or, 'It is work.' The following is the parsing of the former :—

Work—reg. intrans. verb, act., inf., gov. by *must*.
in—prep., showing rel. between *night* and *work*.
dull—adj. of quality, qualg. *night*.
December—proper adj. of quality, qualg. *night*.
night—abs. noun, neut., sing., obj., gov. by *in*.
and—conj., cop., joining the sents. 'I must work' and 'I must work.'
work—as before.
when—adverbial conj., joining the sents. 'I must work' and 'The weather is warm.'
weather—com. noun, neut., sing., nom. to *is*.
is—irreg. intrans. verb, act., ind., pres., 3rd, sing., agreeing with its nom. *weather*.
warm—adj. of quality, qualg. weather.
and—cop. conj., joining the sents. 'The weather is warm' and 'The weather is bright.'
bright—adj. of quality, qualg. *weather*.

Your handwriting is too small and slanting for present style. It looks neat, but is difficult to read. Would get 60 to 70 per cent. of marks.

31. NEMO.—The poet by putting the statement in the form of a question, implies that there is no person who dies who wishes to be forgotten; who would allow his body to pass away from the brightness of life to the cold tomb without a fervent desire to live a little longer. Each dying person relies for sympathy upon some one, who, he hopes, will shed a tear to his memory. The last two lines assert that when life is ebbing quickly away and we are passing to dust and the tomb, the same ardent longing fills us, and the same spirit animates us as in our liveliest moments.

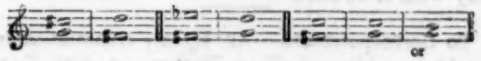
32. EXCELSIOR.—No. Fowle's Latin Books (Sonnenschein and Co., Paternoster Square) are excellent. Also Dr. Smith's, published by Mr. John Murray, Albemarle Street, W.

33. G. SKELLAND.—Large hand 90 per cent.; small hand, 80 per cent. Yes.

34. CÆSAR II.—The Latin Lessons will be resumed in the PRACTICAL TEACHER shortly.

35. ALBATROSS.—Solutions of your query by arithmetic and by algebra appeared in our issue for January, 1884. The answer is 18 miles.

36. WAMBRA.—



Publications Received.

Akrill (C.)—
Akrill's Arithmetical and Spelling Test Cards. Standards I. to VII.

Blackie and Son—
Algebra. Part I.

Cassell and Co., Limited—
Handbook of the New Code. By J. F. Moss.
Cassell's Modern School Test Cards. Standards I. to VII.

Chambers (W. and R.)—
Elements of Euclid. Book I. By J. S. Mackay, M.A., F.R.S.E.
Robinson Crusoe.
A Course of Arithmetic. Standards III. to VII. By T. B. Ellery, M.C.P.
Magnetism. Part I. By H. C. Tarn.

Fletcher (J. S.) and Co.—
Legs and Wings. By Theodore Wood.

Heywood (John)—
Analysis of the Book of Genesis. By Rev. T. Boston Johnstone.
Elements of Linear Perspective. By Seddon Wildeblood, F.S.Sc.
The Try Arithmetic. By Dennis Heywood.
Answers to ditto.

Hodder and Stoughton—
From Log Cabin to White House. By W. H. Thayer.
The Red House in the Suburbs. By Mrs. R. O'Reilly.
Fern Glen Farm. By Helen P. Redden.

Jarrold and Sons—
Practical Help for Infant Teachers. By J. E. Singleton.

Johnston (A.)—
Johnston's Standard Copy Books. Nos. 1 to 8, and Kindergarten Number.

Letts, Son and Co., Limited—
Letts's Illustrated Household Magazine. Part 19. September.

Longmans and Co.—
Longman's Geographical Reader—The British Islands.
Longman's Magazine. September.
A System of Logic. By John Stuart Mill.

Miscellaneous—
The Civil Service Competitor. No. 2.

Murby (T.)—
Langton's Examples in Arithmetic. Standard VI.
Algebra for Beginners. Stage I. By W. Dodds.

Relfe Bros.—
The Church Catechism. By A. Roberts, F.R.A.S., F.R.G.S. (Public Examination Scripture Manuals.)

Simpkin and Co.—
The Shilling Geography. By Dr. Morrison.

Smith, Elder and Co.—
The Cornhill Magazine. September.

Trubner and Co.—
Lessons for Deaf and Dumb Children. Parts I. and II. By W. Van Praagh.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Matriculation Hints.

By Henry A. Reatchlous, M.A. (Lond.), B.Sc.,

Westminster Training College.

A very slender preparation is often thought sufficient to pass the examination in chemistry. Candidates have been known to get through who had learned all the chemistry they knew by reading a book. The chance of doing so at present is believed to be exceedingly small. It is now comparatively easy to get sound elementary instruction in chemistry. Science classes in connection with the Science and Art Department or the City Guilds are found in almost all parts of the country. The student could hardly do better than join one of these classes, and especially the classes formed for the practical study of the subject. If time is a great consideration, he might arrange to work in a laboratory for a few hours a week under the direction of a competent teacher. Of course there are cases where it is impossible to get assistance of this sort; and where, as a last resort, experiments must either be done at home or omitted altogether. Patience, ingenuity, and a small outlay will, however, make it possible to do a good deal of instructive work.

There is a pamphlet called 'Outline of Experiments suitable for illustrating elementary instruction in Chemistry' (Chapman and Hall, price 2d.). It is meant to be a guide as to the general character of instruction, and directs attention to points which should on no account be omitted. These experiments do not cover the whole course: there are none on bromine, iodine, fluorine, phosphorus, or silicon. But they serve as excellent specimens, and should all be repeated if possible.

It may be well to remind the student who is able to get the kind of instruction he wants, that he should not rest satisfied with merely preparing the compounds and examining their properties. The most distinctive feature of the present method of teaching physical science is the constant reference to weighing and measuring. This practice can hardly yet be said to have extended to chemistry. Students have been accustomed to attend courses of lectures and study the reactions of the chief elements and compounds before proceeding to quantitative work. This custom is slowly passing away. In a little book called 'Experimental Chemistry for Junior Students' (Longmans and Co.), Professor Reynolds drew attention to the importance of considering the quantities as well as the properties of the bodies under examination. This attempt was believed to be a step in the right direction. Within the last few months Professor Ramsay has published 'Experimental Proofs of Chemical Theory' (Macmillan and Co.). The professor tells us that the fundamental principles of chemistry rest on experimental proof, and it is the object of his short book to give such instruction as will enable the student to demonstrate approximately the truth of these principles. To do this it is necessary to make measurements of volume and mass, of temperature and pressure. To buy the book and read it and do no more would be to make an improper use of it; some at least of the many interesting measurements should be attempted.

The outline of experiments already mentioned will be a useful guide for the work it covers. For the sake of those who may not be in a position to judge for themselves what to pay most attention to, a few experiments on the remaining elements are appended.

Prepare a small quantity of bromine, compare its properties with those of chlorine; add sodium hydrate to bromine: sodium bromide and bromate are formed; evaporate and ignite; sodium bromide remains. Prepare HBr, either by using Br and P and water, or by passing a current of H_2S into bromine water and filtering. Volatilize a fragment of iodine, and observe

the colour, and prepare some from KI. Potassium iodide can be prepared in a similar way to sodium bromide. HI can be prepared in solution by passing H_2S into water in which I is suspended. Add chlorine water to a solution of a bromide and an iodide, and shake up with ether or benzene, notice the coloured ring at the top. Remember that HBr and HI cannot be prepared like HCl, as part of the halogen acid is decomposed by the H_2SO_4.

Powder up some CaF_2 and add concentrated H_2SO_4 and warm; the HF will etch glass. Put a little white sand and CaF_2 in a test tube, add concentrated H_2SO_4 and warm; take a glass rod and wet it; lower it in the tube and observe the frosted appearance of the drop of water at the end of it. The H_2SO_4 liberated HF from the fluoride. This has the property of dissolving the SiO_2, forming gaseous SiH_4; when this meets water it is decomposed, according to the equation $3SiH_4 + 2H_2O = 2H_2SiF_6 + SiO_2$. These changes are interesting: the deposition of SiO_2 on the glass rod is a test for the presence of a fluoride.

Phosphorus will have been used in connection with oxygen, and as a means of determining the amount of oxygen of the air. A small piece of P may be dissolved CS_2 in a test tube; if the contents be poured on a piece of paper or a duster the CS_2 will evaporate and the finely-divided P will take fire spontaneously. This and all other experiments with phosphorus need very great caution. A fragment of P can be converted into the amorphous variety by heating it in a tube containing CO_2. Notice the energy with which P_2O_5 unites with water when dropped into it. Prepare some PH_3, observing the usual cautions. When burnt in oxygen PH_3 becomes H_3PO_4. P unites with Cl, Br, and I. Add a fragment of P to a few crystals of I; the P ignites spontaneously, PI_3 is formed. Test for phosphoric acid with nitric acid and ammonium molybdate. The most interesting experiment in connection with silicon is the preparation of amorphous silica from flint or white sand. To do this, heat some white sand with six times its weight of fusion mixture on platinum foil in the blow-pipe until the CO_2 ceases to be given off. The whole should then be well soaked in water, in which it should entirely dissolve. Hydrochloric acid is added till the whole is acid to litmus paper. The solution may now be slowly evaporated; water is added to wash away the chlorides of sodium and potassium, and then the silica is dried and heated. The amorphous silica is left as a white, dazzling, and very light powder.

There is apparently with many students a great difficulty in working questions where volumes of gases are concerned. It is only rarely that one gets a correct answer to a question like this:—Twenty litres of NH_3 are decomposed, what will be the volume of the nitrogen and the hydrogen liberated? If the equations expressing the reactions are written in molecules we can take the number of molecules as volumes, and the difficulty vanishes at once; thus $20NH_3 = 10N_2 + 30H_2$—ten litres of nitrogen and thirty of hydrogen. Similarly if we want to know how many cc.'s of oxygen are required to burn completely twenty cc.'s of C_2H_4, the equation $C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$ shows us that one cc. of C_2H_4 requires three of oxygen, and 20 would therefore require 60 cc.'s.

Terms like oxydizing [*i.e.*, increasing the negative element or group, as CO into CO_2, $FeCl_2$ into Fe_2Cl_6, $FeSO_4$ into $Fe_2(SO_4)_3$] and reducing should be well understood, and also the action of reducing agents like H, C, SO_2, HI, and oxydizing agents like HNO_3, Cl, $KMnO_4$, $KClO_3$.

Very excellent instruction on many points mentioned in this article will be found in the lessons on chemistry in course of publication in this magazine.

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR OCTOBER, 1884.

STANDARD III.

A. 1. 823+23.
2. 945+50.
3. 1914+36.

B. 1. 4615+35.
2. 2736+43.
3. 3385+6.

C. 1. 9007+113.
2. 4867+20.
3. 5567+224.

D. 1. 110,992+1561.
2. 8470+3490.
3. 27,065+2637.

E. 1. £27 15s. 11d.
2. £347 13s. 6½d.
3. £716 3s. 3½d.

F. 1. £309 12s. 10½d.
2. £927 8s. 2½d.
3. £1813 8s. 9½d.

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A. 1. £193,890 6s. 11½d.
2. £94,865 8s. 0½d.
3. £162,558 0s. 9d.

B. 1. £54 1s. 0⅜d. + 33.
2. £8 16s. 11¾d. + 57.
3. 2s. 2⅜d. + 338.

C. 1. 551,920 drms.
2. 22,222 Eng. ells. 1 qr. 1 in.
3. 284 mls. 29 po. ½ yd.

D. 1. £141 15s. 0d.
2. £2 1s. 1d. + 220.
£187 10s.
3. £11 9s. 1d.

E. 1. £653,184.
2. £9438 13s. 0½d.
3. £138 0s. 3d.

F. 1. 2d.
2. £18 13s. 4d.
3. 476 parcels.

STANDARD V.

A. 1. £3640 17s. 8⅓d.
2. £58,065 11s. 3d.
3. £11,510 5s.

B. 1. £447 8s. 2⅜d. ⅝.
2. £1106 5s. 5½d.
3. £108 2s. 2½d.

C. 1. 9 lbs.
2. 41$\frac{19}{20}$ lbs.
3. £168.

D. 1. $\frac{11}{144}$.
2. $\frac{11}{12}$.
3. $\frac{11}{12}$.

E. 1. £23 8s. 8⅜d.
2. £188 5s. 3½d. ⅜.
3. £4 5s. 8½d.

F. 1. 3$\frac{1}{8}$ ozs.
2. £23 12s. 6d.
3. 810.

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A. 1. 8$\frac{1}{144}$.
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ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR OCTOBER, 1884.

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B. 1. 17,827	F. 1. 15,780
2. 2997	2. 10,251+4
3. 20,985	3. 5733+4
C. 1. 278,194	G. 1. 8244+5
2. 447,777	2. 2864+8
3. 10,545,040	3. 1810+10
D. 1. 4,641,955	H. 1. 7561+45
2. 67,175,250	2. 756+320
3. 95,417,400	3. 7835+53

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

EXAMPLES ON THE ELECTROLYSIS OF WATER (*For Solution*).

(27) 9 decagrams of water are electrolysed. What weight of hydrogen, what volume of oxygen are given off?

1 decagram ; 56 litres.

(28) 90 cc. water are electrolysed. What is the combined weight of the hydrogen and oxygen given off?.....90 grams.

(29) The combined volume of the two gases evolved is 5 hectolitres, 6 decalitres. What weight of water is used?

3 hectograms.

FOURTH PREPARATION. FROM STEAM AND IRON.

(1) *Laboratory Method.*—Charge a gun barrel, 3 feet in length, with iron tintacks. Fit into each end a perforated

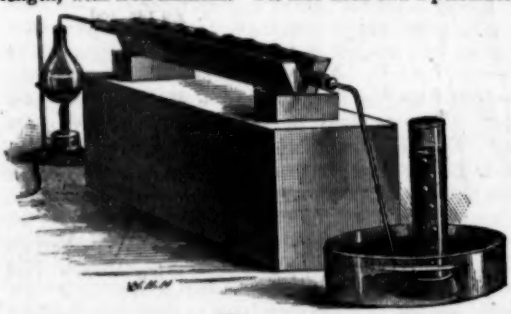

Fig. 11.

cork. Through one cork pass a delivery tube, bent at a right angle, about 6 inches from the point where it enters the cork, and again bent at an obtuse angle at a convenient place for the introduction of the free end of the tube into the opening of the bee-hive. Through the other cork pass a piece of glass tubing whose other end perforates the cork of a large flask, three parts filled with boiling water. Support the gun-barrel on a gas furnace or a charcoal furnace (Fig. 11.), and the flask on a tripod, over a Bunsen's burner. The heat from the burner drives off the water in the flask as steam. The steam passing over the red-hot iron nails, gives up its oxygen to them, while the hydrogen gas passes out by the tube, bubbles up through the water in the pneumatic trough, and is caught by displacement of the water in the gas-jars. Some of the escaping gas should also be caught by displacement of air. The compound that results from the union of the metal iron with the gas oxygen is the magnetic or black oxide of iron.

(2) *Symbols.*—$3\,Fe+4H^2O=Fe_3O_4+4\,H^2$. Fe^3O^4 may be written FeO (ferrous oxide), Fe_2O_3 (ferric oxide). The endings 'ous' and 'ic' are used in naming compounds with greater or less quantity of oxygen. This oxide is sometimes called ferroso-ferric oxide, or triferric tetroxide.

(3) *Weights and Volumes.*—The weight-number of iron =56, of H=1, of O=16. $3\,Fe=3\times56=168$. $4\,H^2O=4(H^2+O)=4(2+16)=4\times18=72$. $Fe_3O_4=3Fe+4O=3\times56+4\times16=168+64=232$. $4\,H^2=8$ by weight, and also 8 parts by volume.

$$3\,Fe+4\,H^2O=Fe^3O^4+4\,H^2$$
$$168\ +\ 72\ =\ 232\ +8$$

8 vols. (8×11·2 litres.)

For the last time I explain in full the meaning of the numbers given. If over 168 parts by weight (say grams) of iron, 72 parts by weight (say grams) of steam are passed, 232 grams of magnetic oxide of iron are formed, and 8 parts by weight (say grams), or 8 parts by volume (say 89·6 litres) of hydrogen are evolved. It must never be forgotten that all these calculations based upon the weight-numbers and laws of volume have reference only to the normal temperature 0°C, and the normal pressure 760 mm.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM STEAM AND IRON (*Solved*).

(36) What weight of iron would be necessary for the complete decomposition of 8 grams of steam?

72 grams H^2O need 168 grams Fe.
1 gram ,, needs $\frac{168}{72}$,, ,,
8 grams ,, need $\frac{168\times8}{72}$,, $= 18\frac{2}{3}$ grams.

(37) Required 200 cc. hydrogen. What weight of steam must be passed over red-hot iron in order to obtain it?

89·6 litres=89600 cc. H require 72 grams H^2O
1 ,, requires $\frac{72}{89600}$,, ,,
200 ,, require $\frac{72\times200}{89600}$,, $= \frac{9}{56}$ grams.

(38) The steam from 16 cc. water is passed over red-hot iron. By how much does the iron increase in weight?

16 cc. water=16 grams, and yield 16 grams weight of steam.
72 grams H^2O cause 168 grams Fe to become 232 grams Fe_3O_4
72 ,, ,, ,, $232-168=64$ grams increase of weight.
1 gram ,, causes $\frac{64}{72}$,, ,, ,,
16 grams ,, cause $\frac{64\times16}{72}$,, ,, ,,
$= 14\frac{2}{9}$ grams.

EXAMPLES ON THE FORMATION OF HYDROGEN FROM STEAM AND IRON (*for Solution*).

(30) What weight of steam must be passed over red-hot iron to yield 560 cc. hydrogen?.....$\frac{9}{14}$ gram.

(31) Steam is passed over 1 hectogram, 1 decagram, 2 grams of iron. What weight of hydrogen is evolved?.....$5\frac{1}{3}$ grams.

(32) The iron oxide at the end of an experiment is found to weigh 290 grams. What volume of hydrogen has been formed?

112 litres.

Fifth Preparation. From Zinc and Sodium Hydrate.

(1) *Laboratory Method.*—Place a solution of caustic soda in a flask with some zinc and apply heat, catching the hydrogen gas that is evolved by displacement of water in the gas-jars in the pneumatic trough. Sodium zincate is formed and remains in the flask. Like results follow if caustic potash is used.

(2) *Symbols.*— $2Na\,H\,O + Zn = Na_2\,Zn\,O_2 + H^2$.

(3) *Weight-Nos. and volumes.*— $2(23+1+16)+65 = 46+65+32+2$

80 143

2 vols.

Question on the Formation of Hydrogen from Zinc and Sodium Hydrate (*Solved*).

(38*a*) If thirteen grams of zinc are heated with caustic soda, find the weight of hydrogen evolved.

With 65 grams of zinc, 2 grams H are evolved.

" 1 gram " $\frac{2}{65}$ " " "

" 13 grams " $\frac{2\times13}{65}$ " " "

$\frac{1}{5}$ gram.

Question on the Formation of Hydrogen from Zinc and Sodium Hydrate (*for Solution*).

(32*a*) What weight of potassium zincate is formed when 112 grams of caustic potash are completely decomposed by zinc?...

175 grams.

(To be continued.)

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How to Teach Botany.

BY J. W. WREN,

Head-Master of the Board School, Duke Street, Deptford.

In studying the functions of leaves, the teacher would be careful to point out how the leaf agrees with the root in being able to absorb food, but, in addition to this, it is also able to assimilate it. It is a breathing organ, an organ of transpiration, circulation, and in some cases—*e.g.*, Tropœolum—of support. A section through the epidermis of a leaf placed under the microscope would show the little organs (stomates) by which transpiration is regulated. That leaves give off oxygen gas may be nicely shown by the following experiment. A few leaves soaked in water, and then laid in spring water and exposed to direct sunlight, will give off a continuous stream of oxygen, which will rise in bubbles through the water.

In the first course the scholars will have learnt the names and relative positions of the various parts of a perfect flower. In teaching the functions of the different parts, a few flower-buds will serve to show that the calyx and corolla are protective floral organs. It would be pointed out by the teacher that the rich and variegated colours of the corolla, together with the sweet odours of the flowers, serve to attract insects. The scholars will have noticed how diligently the little insects search for the honey stored up in the nectary. Whilst endeavouring to obtain this, the insect comes in contact with the anther, and the pollen is scattered over portions of its body, and, being carried away, adheres to the glutinous stigma of the next flower visited. In this way it will be shown what important agents insects are in the fertilisation of flowers.

By selecting suitable specimens, the structures and functions of stamens and pistil may be studied. After having learnt where and how the grains of pollen are produced, it will be shown that they must necessarily fertilise the ovules if the ovary and ovules are to perform their functions. A section through the ovary of some flowering plant at the time of flowering would serve to show the way in which the pollen grains which have been caught upon the stigma grow down into the ovary and penetrate the tissues of the ovule.

It will now be found to be a capital plan to exercise the scholars in describing plants. This serves two purposes, viz., it serves to fix in the memory all that has been previously taught, and to increase the interest in the study of botany. A scholar will have far less difficulty in remembering botanical terms if he be taught how to make a simple dissection and description of a plant.

The following is a good plan for describing a plant in simple language :—

Root.—Kind.
Stem.—Kind (herbaceous, shrubby, or woody).
" Shape (rounded, angular, square, ribbed, etc.).
" Direction (upright, creeping, climbing, etc.).
" Surface (smooth, hairy, rough, etc.).
Leaves.—Insertion (opposite, alternate, radical, etc.).
" Petiole (presence or absence).
" Lamina (simple or compound, venation, margin, incision, apex, general outline, smooth, hairy, etc.).
Inflorescence.—Kind of inflorescence.
Flower.—(1) Calyx (gamo or polysepalous, number of sepals, adhesion.)
" (2) Corolla (gamo or polypetalous, number, adhesion).
" (3) Stamens (cohesion, number, adhesion).
" (4) Pistil (cohesion, number of carpels, adhesion, placentation, number of ovules).

Of course any technical terms used in the above plan would have been made familiar to the scholar in some of the previous lessons.

Stage III.

The third stage is as easy to teach as the first, and quite as full of interest for the young scholar. Having already been taught the distinctive characteristics of the two great classes of flowering plants, the third stage provides for the introduction of the study of the cryptogams or acotyledons. Having already acquired some facility in observing, the comparison of flowering with the so-called flowerless plants is a subject full of interest for the young scholar. If the mature frond of a fern is allowed in autumn to wither up upon a sheet of paper in a dry place, an abundance of spores are readily obtained for experiment. A few examined microscopically will convey a correct notion as to their nature. The teacher will point out the difference between the spores of acotyledons and the seeds of flowering plants. Although the spores serve the purpose of seeds they contain no embryo or young plant. The manner of their germination may be easily demonstrated. A few being sown on some damp soil, and covered with a glass, the growth of the tiny, leaf-like expansions from each germinating spore, together with the indifferent way in which the tiny rootlets are given off from the under surface, may be easily shown. The manner in which the germinating spore gradually developes into a fern is next dealt with, so that the scholars will then have in their note-books a brief account of the life-history of a fern. The large common hair-moss serves well as a type of the moss family. Specimens being before the scholars, they will notice the difference of growth in the ferns and mosses. As some mosses bear their fruit during the winter, the

study of this part of the subject may be left until the time when the flowering plants cannot be readily procured.

The formation of the different kinds of fruits can be easily studied from specimens. Having pointed out that the fruit is really the ripened ovary, and that it usually encloses the seeds, it is advisable to study the fruits in groups. In the first group would come the nut, achene, drupe, berry, etc., being those which do not shed their seeds when ripe (indeluscent). In the second group the legume, follicle, capsule, and such fruits as shed their seeds (deluscent) would be included. After studying the mode of formation of the various kinds of fruits, they should be divided into useful and poisonous fruits, and they should be studied from this point of view. Experience shows that children may gain such a knowledge of botany, even by having only two lessons weekly for three consecutive years, as will enable them to recognise upon many an unknown plant its relation to a wholesome or dangerous natural order.

The code next provides for the study of the structure of the seed. A bean and a grain of wheat are mentioned. Providing each of the scholars with a large specimen—as, for instance, a broad bean—the teacher will proceed to examine it carefully. He will point out the scar or mark where the seed was attached to the fruit. He will point out that at one end of this there is a tiny aperture. He can show that this is so by soaking a bean in hot water for a short time, and then gently squeezing it, a drop of water is seen to escape by this aperture. Peeling the skin from off the seed, the scholars will notice the two coats. Upon laying the seed open the teacher will draw attention to each part which goes to make up the body of the seed, viz., the embryo or young plant, and the two large, fleshy lobes or cotyledons. He will point out that the mass within the coatings is entirely made up of the embryo. When studying the structure of the grain of wheat they will learn that there is in the nucleus of the seed a substance, albumen, in addition to the embryo of the plant. In addition to this, another point of difference will be pointed out. The seed of the bean contained two cotyledons, whereas the wheat grain contains only one. This causes the division of flowering plants into the two classes, dicotyledons and monocotyledons.

In studying the phenomena of germination the teacher will be greatly assisted in his explanations if he has a number of seeds in different stages of germination. He will first of all point out that certain conditions are essential to germination. They are moisture, temperature, air, and darkness.

By means of his specimens he will be able to show the whole process of germination. The seed absorbs moisture, and becomes swollen; the embryo enlarges and ruptures the integument, protrudes, and the growth of a new plant commences. The great difference between dicotyledons and monocotyledons with regard to the formation of the young root will be here pointed out. In the germinating bean it will be observed that the radicle is directly prolonged, and no branching takes place until after the root has left the seed, while in the grain of wheat it will be noticed that there is a branching within the seed, and the radicle is not directly produced.

In speaking of the changes which the seed undergoes during germination, opportunity is afforded to the teacher of imparting some elementary instruction in chemistry. He will point out that during the process of germination chemical action sets in. Some of the nitrogenous matters are changed into a substance known as diastase. This body has the power of changing starch into sugar. If the embryo plant is to grow it must receive food, but the starch by which it is surrounded is insoluble, and therefore cannot be taken in; but by the action of this diastase the starch is changed into dextrine, and then into grape sugar. The plantlet absorbs this sugar, so it lives for a time upon the nutriment contained in the body of the seed. At this stage a lesson on the malting of barley would be highly interesting and instructive, as the scholars would readily comprehend the reasons for the various processes the grain undergoes. Of course, the amount of botanical knowledge that can be gained by a scholar during his school days is not great. If, however, the directions of the code are faithfully carried out, and the teaching is intelligent and effective, a sure foundation will be laid for more advanced botanical studies. What more ennobling pastime can be found than looking on the face of nature? What greater benefit can a teacher confer upon his or her scholars than to implant in them a love of flowers? What study is more suited to lead them to admire the works of 'Him who is wonderful in counsel, and excellent in working'? Or what can give them in after life a greater pleasure than to take Longfellow's advice:—

> 'If thou art worn and hard beset
> With sorrows that thou wouldst forget;
> If thou wouldst read a lesson that will keep
> Thy heart from fainting, and thy soul from sleep,
> Go to the woods and hills! No tears
> Dim the sweet look that nature wears.'

Professor Wilson has penned some good remarks on the value of a general knowledge of botany. He says, 'How many of our young men who visit foreign lands, bent on commercial enterprise, could tell whether the exudation from a tree was a gum, a sugar, a manna, a resin, a camphor, or a caoutchouc? whether a particular tree would yield oil or not, or fibres suitable for fabrics, rope, or paper? whether a wood was soft or hard, lasting or destructible?' No one can doubt that such knowledge may be of the utmost value in every-day life, as well as opening out to our pupils new fields of pleasure and interest whenever they ramble over the hills or along green lanes; for all true lovers of nature find 'Books in running brooks, sermons in stones, and good in everything.'

(To be continued.)

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THE SCRIPTURE INSTRUCTION.—'I have no means of comparing the work done in other Board Schools with the results to which I have now directed attention; but from my former experience as a diocesan inspector of schools, I am in a position to say that the Scriptural instruction given at the present time in the London Board Schools is given in a very thorough and efficient manner. Dogmatic teaching is outside the limits of Board Schools, and to those who cannot conceive of religion apart from dogma, the best Scriptural teaching must always fall short of their ideal of what religious instruction should be. But those who value the study of the Bible as an important instrument of Scriptural and intellectual culture; those who think that there can be sound ethical teaching apart from religious sanctions—such persons must rejoice in the evidence as suggested by this report that some 300,000 children are at the present time being thoroughly well instructed in the London Board Schools in the elementary truths of the Christian religion.'—*The Rev. T. D. C. Morse, in the Times.*

THE DIRECTRESS OF NEEDLEWORK.

WE are asked to reprint the following paragraph from the *Schoolmaster*, and the annexed reply of Mr. Hughes. The paragraph ran thus: 'H.M. Inspectors are forbidden, and we think rightly, to attach their names to any school-books. Can any one say why the same measure is not meted out to the only female official in the Department? The directress of needlework affixes her name to a series of Standard needlework manuals about to be published by Mr. Hughes, apparently as a matter of course. Impartiality would dictate a similar treatment of all the officials of the Department; but it is easy to forecast the unsatisfactory result which would spring from the same liberty being granted to H.M. Inspectors. The inference is obvious.' The following is the reply of Mr. Hughes, addressed to the editor of the paper in which the paragraph appeared:—'Pemit me to thank you most cordially for your interesting and valuable paragraph on page 327 of your last issue anent Miss Jones's "Self-Teaching Needlework Manuals" just published by me. The explanation you asked for is soon given. I had the good fortune to secure Miss Jones's able services long before she was connected with the Education Department. Upon receiving her present official appointment as the directress of needlework, I at once made it known in my advertisements; had I not done so, I am afraid that even you, sir, would have charged me with a lamentable lack of business tact. One has always a few kind Christian friends—kinsfolk, I should think, of your paragraphist—ready to set one right the moment one swerves from the path of rectitude. So the Department were apprised of the fact that Miss Jones was actually writing school-books, whereupon that lady frankly explained the nature of the engagements she had entered into with me. With a readiness which redounds to the credit of the authorities at Whitehall, they allowed Miss Jones to complete her contract in an honourable manner, at the same time prohibiting her, as is their rule, from affixing her name to any new venture. This lady, to whom you politely refer as "the only female official in the Department," has, I may add, no pecuniary interest either in the publications you have been good enough to draw attention to, or in her "Manual of Plain Needlework and Cutting-Out," which I also have the honour to publish. It is really refreshing, sir, to see the *Schoolmaster* step out of the grandmotherly rut it has so long run in, and exact fair-play and impartiality all round. I am sure you would greatly add to the interest of your journal—especially among publishers, who contribute so largely to its revenue—if you would commission the benevolent scribe who "did" the needlework paragraph to continue his philanthropic labours, and inquire into a few other cases of apparent injustice. And as charity proverbially begins at home, he might inform your readers how it is that the PRACTICAL TEACHER, and other magazines which I edit, are, though regularly sent to your office, rarely ever acknowledged, much less noticed in the review column, while a penny monthly conducted by the most prominent member of your editorial council is fulsomely praised almost every month. I have a hazy recollection, sir, that when I was a small boy, spelling my way through a certain good old book, I came across something about "beams" and "motes" in the eye. It might do your large-hearted contributor no harm to hunt up that chapter.—I am, sir, faithfully yours, JOSEPH HUGHES, Pilgrim Street, Ludgate Hill, E.C. *September 8th*, 1884.'

MODEL ANSWERS TO THE CERTIFICATE QUESTIONS, 1883.

WE have unfeigned pleasure in informing our readers that we have made arrangements with Mr. Arthur Day, whose name was placed at the top of the first-class certificate list at the recent examination at the Borough Road Training College, to contribute to the November and December issues of the *Practical Teacher*

'MY CERTIFICATE ANSWERS.'

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

Lecturer on Mental and Moral Science at Bedford College, London.

It will be admitted that to enter into the thoughts and feelings of others is the first condition of effective social influence and real social harmony. Now this end can only be achieved by using the restricted range of feeling that falls to our own lot as a key to the inner life of other human beings. The education of the Imagination means employing the slender stock of personal experience to open up a new world of thought and feeling, in which the materials are essentially the same, but larger in amount, and of greater complexity. Without committing ourselves to the assertion that the moral consciousness is wholly dependent upon sympathy, there is no disputing the fact that a highly developed sympathy is an indispensable condition of its full unfolding. Now sympathy is the being affected by the joys and sorrows of others, as if they were our own. A low degree of it is doubtless possible as a mere consequence of unreasoning, gregarious action, but the strict parallelism between its elevation and the pitch of intellectual representation is sufficient evidence that these two are closely implicated. We are callous to others' feelings more often because we do not comprehend than because we wilfully disregard them, and the needed remedy for misdoing is often not so much the wringing of the conscience as the quickening of the Imagination.

The fact that is common to all modes of Imagination is the elaboration of a vague and formless complex conception into the definiteness of a concrete intuition. The action itself is automatic; and the function of discipline is to release the springs of activity, or to lead the mind to assume an attitude favourable for being acted upon by the unconscious spiritual forces. Music pre-eminently possesses this power of releasing the force of Imagination, owing presumably to its capacity of agitating the emotional side of mind, which after all holds the reins of Imagination.

It is here maintained that this power is both inferior and superior to the discursive operations of intellect; inferior, inasmuch as by itself it never gives us the conception of Law, and the grasp of Natural Law is the indispensable condition for correct conduct. But it is also higher than the discursive understanding, inasmuch as the re-clothing of the abstractions of knowledge in the concrete is our nearest point of contact with the Creative Power. The luxuriant imagination of Early Greek Art became in the time of Plato a reproach and a hindrance to moral progress, because the analysis of life, and not its embellishment, was required to afford principles of duty and order. But the philosophy of a Plato, though born of the inquisitive analysis of a Socrates, was assuredly the fruit of a high Imagination, which grasped a principle of moral order, which poetry had vainly striven to embody.

The application to the ordinary intelligence is not so far to seek as it might at first sight appear. It is generally recognised that the child-mind should gain its first truths through the medium of poetry and pleasing fancies. In those first years the brain is unequal to the strain of thinking by conceptions, and it needs a strong allurement to make it enter the field, often

dreary enough, of intellectual labour. Then follows the dry abstract discipline of the schools; to be again succeeded in due course by the realisation of the deeper thoughts hidden in Nature, and the attempt to frame a picture of the world and of human destiny. Knowledge, in short, begins and ends with the concrete and individual; the deeper intuition of the final stage being only possible after a certain familiarity with the unreal and abstract universal.

Here, more perhaps than in most other regions of mind, we must be prepared for great natural inequalities, as also the evil of injurious treatment may be more serious. The Imagination is a delicate instrument, easily blunted by harsh treatment, difficult to restore in good working order when grossly abused. The fruits of misdirection are mainly either a certain intellectual flabbiness and sentimentality, or a hard purblind matter-of-factness. The remedy for the former evil is to supply severer material, on which the eager fancy may be exercised, and to better purpose. To envisage geometrical relations in new aspects, to try to realize the internal movements of bodies, or to re-write thrilling chapters of history, will employ the imaginative power without enfeebling it; and on the other hand, where the ideal nature is very much below par, the sluggish imagination might usefully be jogged by reading the mind to travel with Voltaire's vivacious ancy to other worlds, where the conditions of existence, though fixed and stable enough in themselves, differ *toto cælo* from our own. The severity of truth is not maintained by a low order of the conceptive faculty, rather by the utmost freedom from the thraldom of traditional associations; so that the mind may well compound its ideas *ad libitum*, taking care, however, that its *belief* be strictly limited by the range of verifiable experience. The truth of Fact, when the eye beholds it, is ever found stranger than Fiction.

VI.—The Will and its Training.

It is usual for psychologists, when elucidating the phenomena of mind, to reserve the subject of volition for the concluding portion of their inquiry. This general practice has perhaps given occasion to the belief, as it has not unfrequently been dictated by it, that we have in Will a faculty superposed on the other mental powers, a faculty even of a higher and quite special character. It should, however, be made clear that the only legitimate ground for the postponement of the topic of volition is one of convenience; that no question of principle is involved in such an arrangement; and that to introduce the question of *worth* is to import considerations alien to the scope of Psychology, as a Natural History of Mind. So injurious, however, has been the effect of this uniform practice, that I am not sure that a psychologist would not be rendering a valuable service to science who should break through this long-established custom, and *commence* his exposition with a thorough analysis of our voluntary activity. For indeed I hold it to be plain that will, or something akin to it, is inseparable from mind, and irresolvable into simpler elements. To feel, to think, and to will, are but different aspects of one conscious life. We cannot feel without distinguishing this present impression from its forerunner, without noting points of agreement and difference with a cluster of remembered antecedents, *i.e.*, feeling is implicated with knowing, and feeling that should have no motive power is equally inconceivable; in other words, feeling, thinking, and willing are mutually involved.

Two errors must be signalized here in familiar theories of the Will. The one is, that we have in human volition something which has no prototype in animal will in general; the other that volition is derived from faculties yet more elementary, that it is the result of intellectual laws of association operating on random manifestations of mere animal life. I think there is good reason for denying both these suppositions. To take the last first. What coherent account can be rendered of the process indicated? It looks almost like a reflection of the old creation-hypothesis, the venerable notion that a Cosmos emerged from pre-existing Chaos, that by some mysterious magic a plenum of order was conjured out of a void of disorder. If there was no germ of order in the apparent disorder how could the world-order ever have been manifested? So in this theory of the will, which requires a straining towards an end as the offspring of an aimless spontaneity, what sort of thing must that spontaneity be which has no principle of determination at its core?

But we certainly do not get much more light when we are informed that human will is *sui generis*, that the actions of lower animals are phenomena of reflex action and instinct, are the manifestations, that is, of a physical mechanism, consciousness being either wholly absent or merely concomitant, the animal being a passive instrument used by an extraneous force. Whence came this novel faculty that has no forerunner in the world of lower organization? And what is the proof that there is this gulf between the minds of brute and man? Not only is there no proof, but all the evidence tends the other way. Comparison of the ways of animals with the ways of men shows that all the psychical functions exhibited by man are present in the animal world, though in simpler form, even at the lowest level of animal existence. And careful criticism also pronounces the wit of man unequal to unravelling the last skein of consciousness, and while acknowledging the ingenuity which essays to display the components of complex modes of will, leaves the Will's own essence as an ultimate fact, coeval with the origin of mental life itself.

The task left to the psychologist, then, is to show how, given the ability to relate and react upon impressions, the thoughts and emotions which make up the content of consciousness, are slowly elaborated; and given a selective power, how the organism can turn this material to account for the furtherance of its own and others' well-being.

The forces impelling to voluntary action are called motives; wherever no motive is discernible or conceivable we refuse to characterise the action as voluntary. A true motive is a feeling with a pleasurable or painful quality. The law of the will is said to be the preference of what the individual mind takes to be maximum pleasure, aversion to what is regarded as maximum pain. The case is rarely so simple as that a single motive, a single pleasure or pain, that is, is present to the mind. Usually there are several such pleasures and pains competing for influence, and hence the act will frequently be no index to the amount of mental work which has been previously gone through. It may even happen that the resultant of these forces is total inactivity, in which case the anticipated

pleasure must have been balanced by the idea of sequent pains. In such a case this alternative presentment of pleasing and painful pictures appears in consciousness as a conflict of opposing powers, and the adoption of the course actually taken is described as an act of *choice*. Now, when the forces have been few or all in the same direction, or there is no impediment to action, attention is not called to the fact of a personal reaction on the feelings. It is only where the resistance encountered is considerable, where there has been much 'deliberation,' and consequent 'resolution,' that the circumstance is noted that we take part in the proceedings as persons, and hence effort comes to be considered a characteristic mark of will. But the difference in the two cases is not one of degree, but only of kind. What difference can it make in principle whether the effort is so slight as to be evanescent, or whether the antagonistic forces are so numerous as to give rise to a considerable sense of struggle? The complication of the motives can have nothing to do with the question whether the action be voluntary or involuntary. An action is voluntary when our spiritual nature reacts upon the feelings which, either in fact or in idea, affect the mind. We must take care, however, not to be the slaves of our own instrument, language. The person which embodies the willing power, as we term it, is the formed character of the man—that evolved spiritual organism which is substantially transmitted, which is only so mysterious in its mode of operation because it embodies the tendencies of countless generations of active intelligence. To predict the probable conduct, it is necessary that we have not only a full knowledge of the motives actually present, but large acquaintance with the character; for the conduct will always be the resultant of these two conditions. It is not to be expected that our inferences will be correct when we ignore either factor, least of all when, as is frequently done, we look only at the motive and disregard the sort of mind brought under its influence.

(*To be continued.*)

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Publications Reviewed.

The Elements of Euclid. Books I. to VI., with Deductions, Appendices, and Historical Notes. By John Sturgeon Mackay, M.A., F.R.S.E. W and R. Chambers.

This work has been compiled at the request of the above well-known firm of educational publishers, and will, no doubt, no less on account of its manner and cheapness of production, than of its intrinsic merits, as a text-book of Euclid's method of geometry, demand a large sale.

The author tells us in his preface that he has not adhered uniformly to Dr. Simpson's editions; and we venture to fear that in the second book, by changing the wording of the enunciations of some of the propositions, he has gone almost too far. In these days of examinations—and long may Euclid, as such, find a prominent place in examinations—those text-books will be used most which assist students the best for examination.

We very much doubt whether the average schoolboy, who is being examined in the first two or three books of Euclid, will realise that he has learnt the proposition given to him in the form of—'If a straight line be divided into any two parts, four times the rectangle contained by the whole line and one of the parts, together with the square on the other part, is equivalent to the square of the straight line, which is made up of the whole and that part,' because he has learnt the following: 'The square on the sum of two lines, diminished by the square on their difference, is equal to four times the rectangle contained by the two straight lines.' Yet such is the new enunciation of the old eighth of Book II. In this proposition the editor has omitted the diagonal, retaining it, however, in the other cases where it is found in Simpson.

Other propositions in this book are altered in form by the introduction of the idea of an external section of a line, and what Euclid calls the part produced becomes a segment. This is done, of course, with the idea of coupling together such propositions as the fourth and seventh, or ninth and tenth, but he does not dare to introduce the idea of a line measured in the opposite direction to another line as having a contrary sign, so as to prove such pairs of propositions simultaneously.

In the third book, reflex and straight angles are used in the proofs of two very important propositions without any very great advantage. At the same time we must admit that Euclid acknowledged the possibility of such angles appearing in certain cases, *e.g.*, when he takes any equi-multiples of arcs in vi. 33., he makes no limitation as to the size of the angle the resulting arc would subtend.

The fifth book we are glad to see retained in a geometrical form; for though the lines (one can scarcely call them figures) are omitted, the subject referred to therein is treated in almost exactly the same way as we find it in Dr. Simpson.

At the end of every proposition there are from seven to even fifty questions and riders, and at the end of each book, except the fifth, besides an appendix, there are miscellaneous deductions, depending on the principles proved in the book.

These appendices are very valuable, and deserve careful attention. In them we find, discussed and carefully explained, such new terms, to a schoolboy at least, as 'median of a triangle,' 'orthocentre,' 'centroid,' 'potency of a point,' 'radical axis,' 'harmonic conjugates,' etc., etc. The well-known facts as to the concurrency of certain lines, or that certain points are in the same straight line, are proved in the appendix to Book I. In that to the fourth book we find the interesting properties of the 'nine point circle' discussed, whereas in that to the sixth book the difficult subject of transversals is introduced. Questions on Loci are also given at the end of the books.

Symbols are used freely, even to the objectionable + and −, but the latter is, as we have said above, only used as a sign of subtraction. In one place the author warns examinees that they must not use some of his symbols in England; but is it wise to introduce them in a text-book for students if they are inadmissible in any examination? These defects, if defects they be, are, however, a hundredfold counterbalanced by the thoroughness of the work and the multitude of well-arranged questions and deductions; and we feel convinced that no teacher could take his classes carefully through the work from one end to the other, getting all the questions answered and deductions worked out, without giving them an extraordinary grounding in geometrical reasoning of incalculable advantage to his pupils, whether intending to pursue their mathematical studies any further or not.

The Elements of Euclid. Book I., with Deductions, etc. By J. S. Mackay, M.A.

This is the first third of the above, bound separately for the use of the lower classes. It includes the appendix and deductions to Book I.

Blackie's School Classics. Merchant of Venice. Blackie and Son.

This is a small volume of 104 pp., being one of a series of English School Classics, called into being by the recent changes in the Education Code.

As an appendix to the text (Globe Edition), the editor has conceived the happy idea of giving Lamb's 'story,' which is called a prose edition of the play. The text is preceded by a very short sketch of the dramatist's life and writings, and succeeded by some twenty pages of notes of a very simple, but, to a child, useful character. We heartily commend the edition to others than, as well as, managers of Board and national schools, as a useful and cheap manual.

The Art of Solving Problems in Higher Arithmetic. By the Rev. J. Hunter, M.A. Longmans, Green and Co.

Not very long ago we had the pleasure of drawing our readers' attention to a valuable little work of this author, called Supplementary Arithmetic. This volume may almost be said to be supplementary to that.

No one can peruse carefully the lately set examination papers in this science, without feeling that there are questions in them which do not come under any special rule or rules, as generally given in modern arithmetics. It is to try to show the principle on which such questions are set and may be solved that Mr. Hunter devotes himself.

He says, and rightly, that many of these problems are suggested to an examiner by having an entire arithmetical statement before him, result and all. In an arithmetical statement any term whatever can be chosen as the thing sought, but with very different results as to the difficulty in finding it; *e.g.*, it would be very easy to prove that $(3\times6-8)\ 4=40$ if 40 be the term asked for; but by no means so easy to find the 3, or the 6, or the 8, or even the 4.

Many people would be astonished to find how the majority of children would puzzle over such a question as would result, if the 3 (say) were asked for to complete this statement. The question might run something like this, 'What number, after being multiplied by 6, and then diminished by 8, and this difference multiplied by 4, would give a result of 40?' To take an example of which Mr. Hunter treats. It is not very difficult to find out the difference between two incomes derivable from two investments in certain stocks of the same or different amounts of money; but let this difference be known and one of the elements on which it depends be the thing sought, and the question becomes very often intensely difficult.

The matter of 'unit,' though often introduced into the working of certain questions, is not treated of as a principle—as it might have been. Questions, too, on the interchange of the monies of different countries are entirely omitted, though useful as an intellectual exercise. Unequal divisions, whether the inequality be one of difference or of ratio, are well discussed.

In one or two of the examples, symbols are employed for an unknown quantity, and treated as numbers. Now this, we maintain, is not arithmetic. Whether the following question can be worked by pure arithmetic we will leave to others to decide, but certainly Mr. Hunter has not solved it so:—

'I invested £3,640 in the 4½ per cents., and on the price falling ½ per cent. I transferred the whole to a 6 per cent. stock at 92, and thereby augmented my income by £78 15s. At what price did I buy into the 4½ per cents.?' Mr. Hunter begins by writing N. for the number of cents. bought at first, and treats this N. as if it were known, until we come at last to 139 N.=4865, and so obtains the result.

There is a chapter on Latitude and Longitude, as to the distance between two places on the same parallel of latitude, and the difference of time at places of different longitude, but it is not very valuable, as neither calling forth much thought on the one hand, nor obtaining perfectly accurate results on the other.

Clock problems are coupled with those on racing on circular courses, and give rise to some interesting but not very difficult problems.

The book will be found eminently useful to tutors preparing men for examinations, being well provided with examples. Those not knowing the Author's compromise between the unit and the old method of working questions in proportion, ought to peruse his book on the subject.

Little Children's Hymns and Songs. Hodder and Stoughton.

The compiler of this pretty little volume tells us, in the preface, that the hymns and songs have been chosen as suitable for children to use as children, and only contain thoughts and facts which their little minds can grasp and understand. It is, doubtless, almost painful to hear a band of healthy choristers sing many of the words we find in the Church hymn-books, such as express a longing to leave this world, etc., and it is well in collecting or writing hymns for children not to put words into their mouths that they do not, nay, cannot feel. Some years ago, we remember rather a rage for the biographies of precocious children, in which we read of babies of four longing to die, etc., etc.; but the good taste of the public seems now to have driven away such publications altogether. No doubt familiarity with unsuitable hymns had a good deal to do with these unnatural expressions.

In the index we find such well-known names as J. Keble, H. K. Lewis, Dr. Faber, F. R. Havergal, Jane Taylor, etc.; and George Macdonald's wonderful 'Baby Theodora,' though extracted from a fairy story, is here too, as it ought to be in every collection made for children. That queen of baby song writers, Mrs. Alexander, is also represented, but not in one of her happiest efforts. Many of the songs, we are told, can be obtained set to music in a separate volume.

Murby's Scripture Manuals—Judges. London: Thomas Murby.

We have here a revised and enlarged edition of this particular number of the above manuals. After a short introduction we find two summaries, entitled respectively 'brief' and 'complete.' These are followed by biographical and topographical notes, arranged in alphabetical order, concluding with some short and instructive notes on the text. The little work does not seem likely to replace the story in its Biblical form, which so many of these helps to Bible knowledge seem to aim at. We therefore heartily recommend it. We are glad to see the English equivalents of the Hebrew names given in the biographical notices.

Industrial Curiosities. By Alexander Hay Japp, LL.D. London: T. Fisher Unwin, 26, Paternoster Square.

This is a reprint of a number of papers on Curiosities of the Industrial World contributed by Mr. Japp to various magazines and periodicals. Some idea of the favour with which the public have received the book may be obtained by the fact that this is the third edition. The book is well written, the papers are very interesting, and as varied as they are interesting, ranging from a visit to Chatham and the manufacture of 'locks and safes' at Wolverhampton, to the curiosities of the 'Post Office,' the mysteries of 'Through Traffic,' 'In a Hop Garden,' and other equally curious subjects. We think the literary matter worthy of better illustrations, and that the opportunity might have been taken to bring the information connected with the Post Office down to a later date, some of the reforms advocated having been already adopted. The book will fill a useful place in a school library, and teachers can find material in it for a score of capital object lessons.

A Complete Latin-English and English-Latin Dictionary. By John T. White, D.D., Oxon. Longmans, Green and Co.

This work requires more than the passing notice of a later edition of a well known and justly-valued publication. In the preface, the author tells us he has intro-

duced a peculiarity which he believes to be a novelty in lexicographical works. This peculiarity consists in the introduction of hyphens, to separate the different parts of the words.

When the simple words appear in the compound word in their original form, the hyphens are introduced into the leading word itself, without any remark thereon, but if only the root or a changed form of the simple elements be found in the word, then the elements in their entire form are given afterwards, and the connecting vowels or euphonic consonants are shown by being placed between brackets thus: 'aur-i-fer' is followed by this explanation [aurum-(i)-fero]. In all cases the suffix is carefully separated from the root or stem, but if the suffix be connected by means of a vowel or euphonic consonant, the connecting vowel or consonant is not separated from it, as the 'i' is in 'aurifer': thus:—monstrum is printed mon-strum, and no etymological explanation is given of the 's.' The word 'rostrum' is thus printed: [for rod-trum fr. rodo]. Surely 'rostrum' is written for 'rod-s-trum,' the 'd' being omitted for euphony's sake before the 's,' as in the case of the sigmated tenses of lingual verbs. It is to be hoped that teachers, whose pupils use this dictionary, will study the preface carefully themselves, and then insist upon their pupils examining these etymological facts, so as to give the formation, etc., of each word. We don't suppose one boy in ten, nay, not one in a hundred, ever read the preface to his dictionary, any more than one out of a thousand, who uses the Book of Common Prayer, has read its preface; but we strongly recommend all teachers and those teaching themselves to carefully study this preface before they use the book.

The English into Latin is not much more than half of the length of the first part; but contains most that a student could require for writing Latin, prose or verse.

The book is clearly printed on good paper, and very cheap. We have no doubt it will hold its own place in the hundreds of schools where it is, at present, regularly supplied to those who have no other Latin dictionary.

Public Examination Scripture Manuals. By Arthur Riches, F.R.A.S. The 'Church Catechism.' Relfe Brothers.

This is a set of questions, carefully answered, on the Church Catechism. The sections are well made, and each section carefully redivided. The Scripture proofs are referred to at first, and printed *in extenso* in a subsequent division, the wisdom of which we doubt. At the end of each section there is a subdivision entitled 'Names,' in which some of the names or expressions used in the section are explained—*e.g.*, Beelzebub, Lord of Flies (the chief deity of the Ekronites); Superstition, belief without good evidence.

The 'Duty towards God,' 'towards our neighbour,' and 'The desire' are printed side by side with the Commandments and Lord's Prayer, showing at a glance the commandment or petition referred to in each portion of the 'duties' or 'desire' respectively.

One of the subdivisions of each of the Commandments is headed 'Broken by.' This gives two or three Scripture examples; and in the case of the First and Second Commandments we are sorry to see the following addition: 'And the Romish Church, who,' etc., etc. We are all the more astonished at this, as in the answers on the Sacraments, the author answers two questions, where he might have vilified the Church of Rome, by giving quotations from Hooker. The manual is well printed and very cheap.

A System of Logic, Ratiocinative and Inductive. By John Stuart Mill. London: Longmans, Green and Co.

This is called a 'people's edition,' and consists of the above well-known work, printed—and well printed—on 600 odd pages in double columns, and thus rendered suitable in price for 'the people.' We heartily recommend it to those who have been debarred previously by the expense of the work from obtaining and studying it. We fully expect that the many modern geometries constantly emanating from the press will tend to bring back logic as an examination subject. The study of Euclid was thought to be an efficient substitute for that of logic, and Dr. Simpson's edition of Euclid was, no doubt, an excellent course of ratiocination; but now, when the celebrated 'pons' is supposed to be proved in two lines, though geometry may be taught more quickly, the mind is not trained, as it is by Euclid's longer and more rigid reasoning, and we shall have to have recourse to logic as our great educator.

Elementary Mechanics. By W. J. Harrison, F.G.S. T. Nelson and Sons, Paternoster Row.

This little volume, like all the school-books issued by Messrs. Nelson, is thoroughly well got up. The paper, printing, illustrations, and binding leave nothing to be desired. The book is divided into twenty chapters of six to seven pages each, which are to be regarded as first lessons in Natural Philosophy. It must be remembered that the author of a book of this sort is often not at liberty to do as he likes either in the selection of the matter, or the mode of presenting it. A syllabus has often been drawn up for him, and he adapts his materials to its requirements. Mr. Harrison has given us some very useful information expressed in clear and simple language. There are a few suitable questions on each chapter at the end of the book. It is said that mechanics, as it is called, is a difficult subject to teach. And it may well be. Until scientific men will agree to attach precise meanings to words, good teaching must necessarily be difficult. Take the word force. A boy reads that force is that which changes, or tends to change, the motion of a body. Then he comes to the force of cohesion, of sound, of light, of heat, and finishes up with vital force and centrifugal force. Possibly he may hear of the correlation of the forces, and even the storage of force. Finally, he will be told that force is a rate and nothing else. Could anything be more distressing? Will the Committee on Electrical Units extend their labours and settle a few leading terms, and give us names for the units of velocity, acceleration, and momentum, etc.? This is work imperatively needed, and work which can only be done by the most eminent men of the day.

Chemical Tables for Elementary Students. Adapted to the new Syllabus of the Science and Art Department. By Wm. Noel Kemp, F.C.S. London: Simpkin, Marshall and Co.

This little manual is intended for the use of pupils studying for the Practical Inorganic Examination of the Science and Art Department. The idea of studying science for the purpose of passing an examination is apt to be ridiculed just now. It is the fashion to decry small manuals prepared for such a purpose. And, doubtless, many of them do more harm than good. Public attention is now being powerfully directed toward a study of things themselves instead of the study of what other people say about them. It is quite true that we cannot learn botany or chemistry by reading books or attending lectures. The pupil must see and handle the things for himself. But how many will do this effectively without proper direction? If an ample supply of natural objects were all that is necessary, none of us could complain for want of them. We are all surrounded by things about which many of us remain ignorant the greater part of our lives. Any book, however humble, which leads people to examine things for themselves, and gain a really useful knowledge of them, should be accepted thankfully. The elements of chemical analysis can be taught without the use of any text-book at all, but such a method has many drawbacks. The little work before us is clearly drawn up and well printed. A boy who works through it is not likely to find any difficulty in the practical examination of the elementary stage. We think the book would have been greatly improved by the addition of a few pages of exercises. Boys will not compare the actions of reagents upon different compounds unless they are obliged to do so.

Macaulay's Milton. Edited to illustrate the Laws of Rhetoric and Composition. By Alexander Mackie, M.A. London: Longmans, Green and Co.

This little volume is a relief after the two just reviewed, and is intrinsically, all comparisons apart, an agreeable surprise. Not that Macaulay is, nor even was in his own estimation, quite as great a writer even for the young as Shakespeare. It is Mr. Mackie's method of dealing with the essay on Milton that has the charm of freshness. Very justly he protests, as we have done in reviewing the two Shakespeare plays, against the mere discussion of archaic words and information of a geographical and historical nature. The chief value of a classic is for style, a point to which our Clarendon Press editors and all the crew of small editors that struggle in their wake, pay absolutely no attention. We hope we are not prejudiced in favour of Mr. Mackie, because he endorses views that we had expressed, curiously enough, just before taking for review this work. Macaulay's works combine information with an interesting and, in some respects, an admirable style. As to the information and criticism in the essay under discussion, the former is not very noteworthy, and the latter not very trustworthy. But as a study, active and passive (if we may so say), of literary style, the essay is very useful. As to Macaulay's writing, it is instructive in every way, and not least in the Helot fashion. There is so much in it that should be a warning to the young writer as to how not to do it. Yet Mr. Mackie, with all his righteous protestations, makes the inevitable concession to custom. He gives a series of notes and memoirs of Milton and Macaulay. Despite the concessions, the book is a very good and a very useful one. Beginners, and even those who fondly imagine themselves past masters in composition, can learn the names for all sorts of literary combinations that they have read or even used unconsciously in ignorance, more or less blissful of the nomenclature of the literary art. Epigram, inversion, parallel, construction, metaphor, explicit reference, balance antithesis, together with such barbarisms as synecdoche and antonomasia, are all explained and illustrated. For those who want to know the dry bones of composition, the work of Mr. Mackie will be most useful. They will, of course, keep in mind that the knowledge of these is no more equivalent to writing well, than a skeleton is to a human being.

Chambers' Geographical Readers. Standards III. and IV. London and Edinburgh: W. and R. Chambers.

These books, while avoiding unnecessary multiplication of names, omit no important geographical fact. They are *reading-books*, and not simply text-books on geography. The illustrations are suitable, the maps clear and plentiful, and the lists of words full and carefully selected. Revision lessons are added to each book, and increase the usefulness of the volumes.

From Log-Cabin to White House. By W. M. Thayer. London: Hodder and Stoughton.

When a biography has reached its twenty-third edition, there is but little left for the critic to do. We therefore simply announce that the edition before us is one of rare beauty. This interesting story of President Garfield's life, enriched as it is with twenty superb woodcuts and two steel portraits, and clad in an exquisite binding, cannot fail to form one of the most coveted gift-books of the coming season. It has our heartiest commendation.

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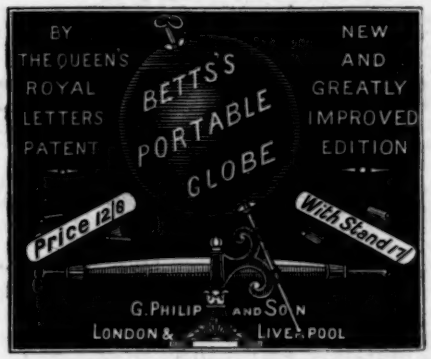

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